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NUCLEAR SCIENCE ABSTRACTS

Vol. 4 No. 18

Table of Contents for September 30, 1950

Category	Abstract	Page
REFERENCE LIST		iii
BIOLOGY AND MEDICINE		803
Radiation Effects	5346	
Radiation Hazards and Protection	5359	
Radiography	5365	
Radiotherapy	5368	
Toxicology Studies	5371	
Tracer Applications	5372	
CHEMISTRY		808
Analytical Procedures	5385	
Deuterium and Deuterium Compounds	5390	
Fluorine and Fluorocarbons	5391	
Graphite	5392	
Laboratories and Laboratory Equipment	5393	
Rare Earths and Rare Earth Compounds	5396	
Separation Procedures	5398	
Spectroscopy	5399	
Syntheses	5400	
Tracer Applications	5404	
Uranium and Uranium Compounds	5405	
ENGINEERING		811
Heat Transfer and Fluid Flow	5408	
Vacuum Systems	5409	
MINERALOGY, METALLURGY, AND CERAMICS		811
Metals and Metallurgy	5410	
Minerals and Mineralogy	5421	
PHYSICS		813
Cosmic Radiation and Mesons	5425	
Instruments	5440	
Isotopes	5444	
Isotopes Separation	5446	
Mass Spectrography	5450	
Mathematics	5451	
Measuring Instruments and Techniques	5453	
Meteorology	5468	
Molecular Structure	5469	
Neutrons	5473	
Nuclear Physics	5478	
Nuclear Properties	5480	
Nuclear Reactors	5492	
Nuclear Transformation	5493	

TABLE OF CONTENTS FOR SEPTEMBER 30, 1950

Category	Abstract	Page
PHYSICS (Cont.)		
Particle Accelerators	5516	
Radiation Absorption and Scattering	5518	
Radioactivity	5528	
Theoretical Physics	5540	
Tracer Applications	5554	
AUTHOR INDEX		A
SUBJECT INDEX		C
NUCLIDE INDEX		K
FOREIGN GEOGRAPHIC INDEX		M
PUBLISHED DOCUMENTS INDEX		M
NNES ANNOUNCEMENTS		P

DOCUMENTS REFERENCE LIST

Vol. 4 No. 18

U. S. ATOMIC ENERGY COMMISSION DECLASSIFIED DOCUMENTS

Document	Title, Author	Abstract
AECD-2851	Magnetic Amplifier Voltage Regulator. J. L. Wolff, Jr.	5440
AECD-2864	Design of Water-Ether Contacting System. Final Report. J. B. Tepe and W. K. Woods.	5398
AECD-2874	Effect of Polonium^{210} and Selenium^{75} in Experimental Schistosoma Mansoni. N. P. Watts and K. P. McConnell.	5346
AECD-2875	Total Cross Sections of Nuclei for 42-Mev Neutrons. R. H. Hildebrand and C. E. Leith.	5493
AECD-2876	Detection of Trace Amounts of Radioactive Materials. P. R. Fields and G. L. Pyle.	5385
AECD-2877	The Reactions of Uranium Oxides and Liquid Nitrogen Tetroxide. G. Gibson and J. J. Katz.	5405
AECD-2878	The Colorimetric Determination of Cyanide in Industrial Wastes by Phenolphthalein. K. Rohde and H. G. Swope.	5386
AECD-2879	Chemistry of Aqueous Uranium(V) Solutions. III. The Uranium(IV)-(V)-(VI) Equilibrium in Perchlorate and Chloride Solutions. F. Nelson and K. Kraus.	5406
AECD-2880	The New Element Berkelium (Atomic Number 97). S. G. Thompson, A. Ghiorso, and G. T. Seaborg.	5444
AECD-2881	Thermal Effects of Atomic Bomb Explosions on Soils at Trinity and Eniwetok. E. Staritzky.	5359
AECD-2882	The Metallography of Zirconium. H. P. Roth.	5410
AECD-2883	The Extrusion of Beryllium. E. C. Creutz, D. G. Gurinsky, J. H. Chapin, R. W. Yancey, F. G. Foote, H. Bethke, and A. R. Kaufmann.	5411
AECD-2884	The Angular Distribution of High Energy Neutrons from Targets Bombarded by 330-Mev Protons. R. D. Miller, D. C. Sewell, and R. W. Wright.	5494
AECD-2885	The New Element Californium (Atomic Number 98). S. G. Thompson, K. Street, Jr., A. Ghiorso, and G. T. Seaborg.	5445

DOCUMENTS REFERENCE LIST

Document	Title, Author	Abstract
AECD-2886	The Relationship of the Cell Surface to Metabolism. The Chemical Nature of Uranium-Complexing Groups of the Cell Surface. A. Rothstein, R. Meier, and C. Larrabee.	5371

U. S. ATOMIC ENERGY COMMISSION UNCLASSIFIED DOCUMENTS

AECU-859	Metabolism of C^{14}-Labeled Urea in Mice. A. B. Hastings, W. Langham, R. E. Carter, and L. J. Roth.	5372
AECU-868	On the Theory of Slow Neutrons Scattering by Solid and Liquid Helium. L. Goldstein and D. W. Sweeney.	5473
AECU-869	The Centroid of a Convex Body. P. C. Hammer.	5451
AECU-870	Matrix Treatment of Relative Orientation of the Multiplex Aero Projector. W. A. Allen.	5452
AECU-871	Sample Temperature in the Carrier Arc. S. Wexler.	5387
AERE-EL-R-229	Vacuum Establishment for the 4-Mev Linear Electron Accelerator. B. G. Loach.	5409
AERE-MED/R-536	A Magnetically Operated Blood Cell Pipette Shaker. C. Sanders, K. C. Perry, A. E. Bennett, J. C. H. Geisow.	5394
AERE-M/R-378	A Simple Temperature Controlled Laboratory Furnace. R. S. Barnes.	5395
AF-TR-5943	Research on Zirconium Alloys. Final Summary Report June 18, 1940 to October 17, 1949. F. B. Litton and S. C. Ogburn, Jr.	5420
COO-14	Second Quarterly Report (Mar. 1, 1950 - May 31, 1950) Preparation of High Purity Magnesium and a Study of the Effects of Non-Metallic and Alkali Metal Impurities on the Corrosion Characteristics of Pure Magnesium. Dow Chemical Company.	5412
CRC-440	The Automatic Control of Electrode Potential. G. C. Barker.	5442
EAH-130	Welding of Tantalum Tubing. N. A. Chapin and W. D. Egnor.	5413
HW-17561	Fast Neutron Counter for Health Physics Measurements. J. S. Reddie and G. H. Whipple.	5453
K-615	Removal of Radioactive Particles from Gases by the Trion Electrostatic Precipitator. T. F. Furlong, H. C. Harrison, J. F. O'Donnell and R. P. Webb.	5468
LE-22	Scintillation Counting. G. Cowper.	5465
MITG-A94	Preliminary Experiments on Continuous Radioassay of Radioactive Ores and Mill Products. D. W. Haney.	5421

DOCUMENTS REFERENCE LIST

Document	Title, Author	Abstract
NAA-SR-77	The Erosion of Graphite by High Temperature Helium Jets. L. Green.	5392
NEPA-1138	Fifteenth Informal Monthly Report on Heat Transfer and Pressure Drop of Air Flowing in Small Tubes. J. N. Addoms and C. L. Kroll.	5408
NYO-663	Self-Diffusion of Metals and Associated Phenomena. B. H. Alexander, R. W. Baluffi, M. H. Dawson, H. P. Kling, and F. D. Rosi.	5414
NYOO-1008	Zirconium and Hafnium: A Bibliography. G. C. Williams, E. G. Baker, Jr., E. W. Holzknecht, and R. G. Moody.	5415
ORNL-714	Instrument Research and Development Quarterly Progress Report for Period Ending April 15, 1950. W. E. Thompson.	5441
UCLA-73	The Isolation, Purification, and Derivatives of Plant Pigments Related to Rutin. T. J. Haley and M. Bassin.	5345
UCRL-579	Radioautographic Technique. D. A. Heller.	5365
UCRL-663	Collisions of High-Energy Nuclear Particles with Nuclei. B. J. Moyer and G. F. Chew.	5474
UCRL-684	On the Relative Production of π^+ and π^--Mesons by Neutrons. H. Bradner, D. J. O'Connell, and B. Rankin.	5425
UCRL-691	Energy Dependence of Proton-Proton Scattering, 18.8 to 31.8 Mev. B. Cork.	5518
UCRL-698	Carrier-Free Radioisotopes from Cyclotron Targets. X. Preparation and Isolation of Mg^{27} from Aluminum. H. R. Haymond, J. Z. Bowers, W. M. Garrison, and J. G. Hamilton.	5495
UCRL-704	Preparation of Labeled Zinc Lactate from Propionic Acid. D. M. Hughes, R. Ostwald, and B. M. Tolbert.	5400
UCRL-719	Cascade Showers in Lead. K. M. Crowe and E. Hayward.	5519
UCRL-740	Synthesis of Potential Cancer-Inhibiting Agents. I. 2,6-Diamino- [3', 2'-h]-Thiazolinopurines. M. Gordon.	5401
UCRL-741	Procedure for the Radiochemical Analysis of Astatine in Biological Material. W. M. Garrison, J. D. Gile, R. D. Maxwell, and J. G. Hamilton.	5388
UCRL-743	Detection of Tritiated Compounds in Paper Chromatography. I. Gray, S. Ikeda, A. A. Benson, and D. Kritchevsky.	5389

BIOLOGY AND MEDICINE

5345 The Isolation, Purification, and Derivatives of Plant Pigments Related to Rutin. Thomas J. Haley and Murray Bassin. UCLA-73, June 5, 1950. 9p.

An improved hot water extraction procedure for the almost quantitative isolation and separation of Morin [3,5,7,2′,4′-pentahydroxyflavone] and Maclurin [2,4,6,3′,4′-pentahydroxybenzophenone] is described. It was found that Morin sublimed at 289-290.5°C and that this property could be utilized in place of solvent recrystallization for purification of crude Morin. By increasing the number of extractions from one to three, a larger yield of Iridin [7-glycoside of 5,7,5′-trihydroxy-6,3′,4′-trimethoxyisoflavone] was obtained from Orris Root. Methods for hydrolysis of the flavonoid glycosides; Iridin, Hesperidin [7-rhamnoglycoside of 4′-methoxy-5,7,3′-trihydroxyflavanone], and Naringen [5-rhamnoglycoside of 5,7,4′-trihydroxyflavanone], to their respective aglycones are described. Irigenol [5,6,7,3′,4′,5′-hexahydroxyisoflavone] has been prepared by demethylation of Irigenin with hydriodic acid. A method for the preparation of the methyl ethers of Morin, Maclurin, Naringenin, and Hesperetin is described. The synthesis of Irigenol hexacetate is reported. (auth)

5346 Effect of Polonium^{210} and Selenium^{75} in Experimental Schistosoma Mansoni Infection in Mice. N. P. Watts and K. P. McConnell. AECD-2874, Apr. 27, 1950, Decl. July 6, 1950. 13p.

Neither alpha nor gamma radiation, as supplied by Po^{210} and Se^{75} in this experiment, have been observed to be damaging to the worm form of Schistosoma mansoni in the experimental infection in mice. 17 references. (auth)

5347 Applied Biophysics. A Symposium. N. Howard-Jones. Brooklyn, N. Y., Chemical Publishing Co., 1949. 293p.

This book is based on a collection of articles in the British Medical Bulletin. The following articles are included: Physics in medicine; Biophysical factors in drug action; A survey of the applications of electronics in medicine; The clinical applications of heat; The mechanics of brain injuries; The biological effects of penetrating radiations; Comparative studies of the biological effects of x-rays, neutrons, and other ionizing radiations; Genetic effects of radiations; The actions of radiations on viruses and bacteria; Quantitative histological analysis of radiation effects in human carcinomata; The measurement of radiation; Total energy absorption in radiotherapy; On technical methods of x-ray therapy; On technical methods in radium therapy; Million-volt therapy; Protective methods in radiology.

5348 The Biologic Action of X-rays on Embryos of Amphibians. Experiments of Transplantation. Teodoro Perri. Riv. biol. 42, 119-54(1950) Jan.-Mar. (in Italian).

In order to analyze the behavior of the different rudimentary organs of irradiated embryos, the author has transplanted such organs on normal embryos, in order to follow their destiny even after the death of the irradiated donors. The following conclusions are listed: (1) The optic vesicle of an embryo, irradiated with certain lethal doses, if it is transplanted on a normal embryo, outlives by a long time the irradiated embryo; in fact, it is sometimes in pretty good condition at the death of the receiver. (2) The fore part of the encephalon is very susceptible, much more than the hind parts. The rudimentary olfactory organ is more resistant than the fore encephalon, but generally less than the optic vesicles. Very resistant are the dorsal cord, the myotomes and the rudimentary tail. (3) In the transplantation of the fore part of the head from irradiated to the normal embryos the disappearance of the fore parts of the encephalon causes the rudimentary olfactive organs to come in mutual contact; the same thing happens with the optic rudimentary organs. (4) The general conclusion is that the embryos irradiated with certain doses of x-rays die, evidently on account of the death of organs indispensable to life, and because those conditions fail that render possible the life of that unity of a superior order which is represented by the organism in its entirety. Some rudimentary organs, however, preserve the capacity to live and to develop themselves at least for a long time, which occurs if they are transplanted on normal embryos. (5) Experiments of transplantation from normal to irradiated embryos and from irradiated to normal embryos, have not brought into evidence that the irradiated medium is in itself hurtful to a normal rudimentary organ, or that the normal medium is itself hurtful to an irradiated rudimentary organ. 35 references. (auth)

5349 The Effect of Cysteine on the Peripheral Blood of the Irradiated Rat. Harvey M. Patt, Douglas E. Smith, and Eugenia Jackson. Blood 5, 758-63(1950) Aug.

A single intravenous injection of cysteine (950 mg/kg) 5 min before total-body exposure of rats to x-rays (800 r) significantly modified the radiation-induced hematologic changes. Depression of the heterophils, lymphocytes, and erythrocytes was less severe and recovery more rapid. The hematologic observations are consistent with the thesis that cysteine reduces the biological effectiveness of the radiation. (auth)

5350 Effects of Irradiation on Nucleic Acid Formation. Lola S. Kelly and Hardin B. Jones. Proc. Soc. Exptl. Biol. Med. 74, 493-7(1950) July.

Mice of the A strain bearing bilateral transplants of mammary carcinoma were used to demonstrate an indirect effect of irradiation on the desoxypentose nucleic acid turnover rate. In 2 experiments the animals were irradiated by means of radioyttrium (Y^{90}) colloids which localize in the liver when injected intravenously and remain at the site of injection when given intramuscularly. The nucleic acid turnover rate was measured by giving a tracer dose of radioactive sodium phosphate (P^{32}), sacrificing the animals after 2 hr, and isolating the desoxypentose nucleic acid from their tumors and livers. The specific activity of the nucleic acid phosphorus was measured and considered to be an index of the turnover rate. It was found necessary to purify the nucleic acid much more carefully than is done in standard methods in order to obtain a constant specific activity upon successive reprecipitations. The animals whose livers were irradiated with 4.25×10^5 ergs showed only 66% of the tumor nucleic acid specific activity of the control group. The animals whose muscles were irradiated with 4.25×10^5 ergs showed only 84% of the tumor nucleic acid specific activity of the control group. Both these experiments definitely confirm the existence of an indirect effect of radiation on the desoxypentose nucleic acid turnover rate. One group of animals received 60 r (1.4×10^5 ergs) total body x-irradiation with 180 kv x-rays and both

the tumors and livers showed a significant depression in the turnover rate. 10 references. (auth)

5351 The Influence of Certain Metallic Ions on the Survival of Rats Receiving a Lethal Dose of X-rays. G. Lambert, J. Maisin, M. Mandart, M. Meersseman, G. Podio, and E. Pluygers. Compt. rend. soc. biol. 144, 444-8(1950) Mar. (in French).

Rats received a total body x-ray dose of 600 r (180 kv) for approximately 13 min. Subcutaneous injections of barium chloride, lithium lactate, or mercuric chloride were administered to some of them either before or after irradiation. The barium and lithium ions hastened death, while mercuric ions seemed to retard it and diminish the percentage of the rats which succumbed.

5352 Irradiation Necrosis of the Head of the Femur. J. T. MacDougall, A. Gibson, and T. H. Williams. Arch. Surg. 61, 325-45(1950) Aug.

A case of irradiation osteonecrosis of the head of the femur is presented, with a brief review of the literature. This is the third reported case of this lesion occurring in a male. A case of irradiation osteonecrosis of the neck of the femur occurring in a woman following irradiation of the pelvis for carcinoma is presented. A short discussion of the clinical findings in such cases is given, the relatively long duration of symptoms prior to demonstrable physical signs and the relatively late occurrence of roentgenologic changes being emphasized. Pain alone as a symptom of metastasis is insufficient reason for ordering roentgen ray therapy. The pathologic findings, both gross and microscopic, demonstrate the basic factor in irradiation injury to be the production of endarteritis obliterans, with subsequent sterile necrosis of bone and cartilage. It is not primarily an inflammatory process. Secondary changes in the joint occur in the presence of added factors, particularly trauma. The total dose of irradiation in itself is not the only determining factor in the occurrence of necrosis of bone, but it is probably the most important one. No evidence of metastasis has been found in the male patient by pathologic and clinical examination, and there is no clinical evidence of metastasis in the female patient. 29 references. (auth)

5353 Lethal Irradiation of the Mouse by X- and γ Rays. Therapeutic Attempts. P. Bonet-Maury and F. Patti. J. Radiol. Electrol. 31, 286-9(1950)(in French).

The lethal effects of x-rays (up to 100,000 r at 200 kv) and γ rays from 10 g of radium were studied on 1143 mice. Survival rates as a function of total dose and time of death after exposure are shown. The $\gamma/\times$ ratio of effectiveness varies from 2.1 to 3.6.

5354 Physiological Effects of Radiant Energy. R. Lowry Dobson and John H. Lawrence. In Annual Review of Physiology, Vol. X, p. 479-500. Stanford, Calif., Annual Reviews, Inc., 1948.

As a review article on the physiological effects of radiant energy an attempt is made to bring out the highlights of recent developments in the field and to mention briefly the pertinent work brought out in the year ending August, 1947. The effects of α, β, γ, x-rays, neutrons, and fission fragments are included. 131 references.

BIOLOGY AND MEDICINE

5355 Protection of Mice Against X-radiation by Thiourea. G. Limperos and W. A. Mosher. Science 112, 86-7 (1950) July 21.

Varying amounts of thiourea were given to mice by intraperitoneal injection in a single dose 5 min before irradiation with a 650 r dose of x-rays and by administration in the drinking water in a concentration of 1% for a period of 6 days before irradiation. Mice receiving thiourea had a lower mortality rate than control mice. The authors believe that thiourea and possibly other reducing agents lower the mortality due to x-radiation because of the protection afforded to certain vital cellular constituents such as nucleic acid.

5356 Several Biological Effects of Weak Radioactivities. C. Champy. Bull. acad. natl. med. 134, 407-8(1950) June 13. (in French).

Frog eggs were placed at various distances from a radium source. Directly after irradiation, those just outside the zone of lethality grew more rapidly than those farther out. This accelerated process was subsequently reversed. The effect of immersion in water containing radioactive substances upon the scarring of wounds in barley root is also discussed.

5357 Some Effects of Testosterone Propionate on Mice Irradiated with X-rays. Friedrich Ellinger. Proc. Soc. Exptl. Biol. Med. 74, 616-19(1950) July.

Administration of testosterone propionate in daily doses of 0.25 and 0.5 mg, respectively, following exposure of mice to the LD_{50} of x-ray, up to 14 days, markedly increased the lethal effect of irradiation. No changes in the x-ray induced organ effects were accomplished in all investigated organs with the exception of the liver. Radiation induced accumulation of sudanophile fat in this organ was definitely suppressed with a larger dose of testosterone. Radiobiological and some clinical implications of these findings are discussed. 15 references. (auth)

5358 Vitamin P Protection Against Radiation. Boris Sokoloff, James B. Redd, and Raymond Dutcher. Science 112, 112-13(1950) July 28.

Rats were fed vitamin P (CVP compound), isolated from citrus waste, both before and after a total-body radiation of 800 r of x-rays. Considerable protection against the near-lethal dose was observed, probably due to the prevention, by the flavanoids present, of an increase in capillary fragility.

5359 Thermal Effects of Atomic Bomb Explosions on Soils at Trinity and Eniwetok. Eugene Staritzky. AECD-2881, June 13, 1950. Decl. Aug. 2, 1950. 18p.

Samples of soils from Trinity and Eniwetok, thermally altered as a result of the test shots of 1945 and 1948, were examined. At Trinity a crust of vesicular silicate glass covers the ground over an area of about 2000 feet diameter. The amount of glass formed is estimated as 17×10^8 grams. Petrographic evidence indicated that temperatures exceeding 1470°C were reached throughout this area. Spectrographic analyses of samples of glass and parent soil showed that the melt was not superheated by more than a few hundred degrees in any portion of the area sampled. The amount of

energy which went into forming the glass is estimated as $(4.3 \pm 0.5)10^{19}$ ergs. Because of exceptionally unfavorable conditions on Eniwetok, no definite information could be obtained from the examination of samples of coral sands collected after the "Sandstone" shots. (auth)

5360 Disposal of Radioactive Wastes from Massachusetts General Hospital. Frank A. Butrico. Massachusetts Institute of Technology, May 19, 1950. 51p. (AEC File No. NP-1623.)

A thesis on an investigation of the disposal of radioactive wastes of I^{131}, P^{32}, and C^{14} is presented. Quantitative study is limited to I^{131}. An estimate of the radioactivity contributed by C^{14} and P^{32} is included. The information obtained indicates that the quantity of P^{32} and C^{14} being discharged did not constitute a hazard. I^{131} was being discharged in concentrations exceeding recommended specifications. 20 references.

5361 Guide to Special Chemicals Handling. Kellex Corporation. Report KLX-08, nd. 82p.

This report contains a number of rules and precautionary measures to be adopted by workers handling or exposed to radioactive materials. 13 references.

5362 Hazards in the Use of Radioactive Static Eliminators and Their Control. John E. Silson. Am. J. Pub. Health 40, 943-52(1950) Aug.

The use of radium coated bars to eliminate static electricity in industrial equipment and the protection of workers from the emanations are described.

5363 Radiological Defense, Vol. III. Armed Forces Special Weapons Project, nd. 140p.

This volume is a series of lectures dealing mainly with problems in handling radioactive materials, the biological effects of radiation, decontamination problems, therapy of radiation illness, and tracer techniques. (auth)

5364 A Simple Method for Opening Quartz Capsules Containing Radioactive Materials. H. H. Coburn and C. C. Roan. Science 112, 125(1950) July 28.

The quartz capsules in which irradiated material is shipped are secured in a socket within a shielding box. A slidable cover on the box carries a small motor for spinning a carborundum cutting disc at the proper height to remove the capsule end. By means of a vacuum connection air is caused to flow into the box to prevent escape of radioactive material.

5365 Radioautographic Technique. Dorothy A. Heller. UCRL-579, Jan. 1950. 33p.

This article is a general review of the subject covering the physical principles involved in making a radioautograph (resolution, emulsions, type particle observed, film development, exposure time, dose), the various methods of preparing samples, and the biological studies to which the techniques have been applied. 96 references.

5366 A Method for Routine Detection of Radiophosphates and Other Radioactive Compounds in Tissues. The Inverted Autograph. Leonard F. Belanger. Anat. Record 107, 149-59(1950) June.

BIOLOGY AND MEDICINE

A modification of the coated autograph technique for the localization of radioactive elements in tissues is described under the name of "inverted autograph." Kodak Matrix emulsion is painted over the unstained celloidin-coated histological section. After exposure, development, and fixation, the combined emulsion-celloidin-tissue preparation is inverted and the section is stained. The advantages are (1) possibility of mass production, (2) working in semi-brightness, (3) retention in the sections of P^{32} present as mineral salt, (4) easier and better staining. (auth)

5367 New Techniques in Autoradiography. John E. Harris, J. F. Sloane, and D. T. King. Nature 166, 25-6(1950) July 1 (Letter to the editor).

The authors describe a method of freeze-drying of tissue samples to be used in autoradiography which solves the problems of preparing the tissues without loss of a soluble tracer and the enormous radiation intensities needed for a successful exposure. Liquid methyl chloride is used as the refrigerant.

5368 The Experimental Application of Radioactive Colloidal Gold in the Treatment of Pelvic Cancer. Alfred I. Sherman, James F. Nolan, and Willard M. Allen. Am. J. Roentgenol. Radium Therapy 64, 75-85(1950) July.

Radioactive gold (Au^{198}) suspended in pectin solution was used as an interstitial therapy method in the treatment of transplanted squamous cell carcinoma in mice. It was found that these tumors could be safely and completely cured, with high survival rates using this therapy. The optimum dose required for cure was found to be 200 to 300 μc per cm^3 of tumor tissue. Radioactive gold in colloidal pectin suspension was injected into the paracervical tissue of rabbits. It was found that the gold entered the lymphatic system and reached the primary and secondary regional lymph nodes. There were definite irradiation effects noted in these areas. Radioactive gold when injected into the peritoneal space found its way into the retroperitoneal lymph nodes causing marked irradiation effects. Radioactive gold in pectin solution was introduced into the uterine horns of rabbits and left in situ. In the presence of this material the usual progestational response with rapid growth and mitosis resulting from stimulation with chorionic gonadotrophin was inhibited. The range of irradiation included the ovaries which also showed irradiation effects. The normal tissue responsiveness had not returned after 6 weeks. The gold was also found phagocytosed and carried to the lymphatics of the submucosal and subperitoneal tissues and to the immediate lymph nodes draining these areas. During the experiments with radioactive gold it became necessary to study and define tissue tolerance levels by this form of radiation therapy. The tissue selected for study was the parametrium of the rabbit. The results indicate that doses of radiogold at therapeutic levels are not injurious to normal structures. The results of these experiments in lower animals qualify the effectiveness and limitations of radioactive colloidal gold in pectin solution as a mode of treatment in carcinoma of the uterus. The physical characteristics of the material and its behavior in relation to biologic processes suggest its use as an adjunct to present methods of radiation therapy in this disease. 21 references. (auth)

BIOLOGY AND MEDICINE

5369 Effects of Radioactive Iodine on Free Sarcoma 37 Cells in the Peritoneal Fluid of the Mouse. Horace Goldie and Paul F. Hahn. Proc. Soc. Expti. Biol. Med. 74, 634-8(1950) July.

CFW mice of 25 g weight were inoculated intraperitoneally with requisite numbers (mostly 10,000) of S-37 cells and treated intraperitoneally with radioactive iodine (I^{131}) (0.2 or 0.4 mc). The fate of tumor cells was studied by repeated withdrawal and examination of peritoneal fluid in each mouse and compared with their fate in control animals (inoculated with the same dose of cells, but untreated or treated with decayed I^{131}). The examination of each specimen of peritoneal fluid consisted (a) in the microscopic assay of integrity and ability for multiplication (percentage of mitoses) of free tumor cells which multiplied in the peritoneal fluid before treatment, and (b) in the biological assay of viability of tumor cells, i.e., their ability to survive and multiply after transfer into new mice. The results indicate that with a single exception (tumor strain C isolated from a treated mouse) all tumor cells suffered loss of viability even after treatment with the minimal dose (0.2 mc) of I^{131}. In most mice this effect was detected only after the failure of tumor cells from treated animals to grow in the peritoneal fluid of new animals. In other animals, where higher dose of radiation was used, or, presumably, where nutrient environment was drastically changed, the tumor cells disintegrated in the body of the treated mouse. Rapid disappearance (after 24 to 48 hr) from the peritoneal fluid of injected radioactive preparation suggested the differentiation between its early and primary effect (which may be the production of a "lethal mutation") and its later secondary effect (cell disintegration) may be due to additional factors (higher dose of radioactivity, drastic changes in the biological medium. (auth)

5370 The Use of the Radioactive Isotope of Cobalt (Co^{60}) in Anticancer Radiotherapy. R. Coliez. J. Radiol. Electrol. 31, 318-9(1950)(in French).

Radioactive cobalt (Co^{60}) has a half-life of 5.3 yr and emits γ rays only slightly less penetrating (1.10 and 1.30 Mev) than radium C and E. It is produced in the slow neutron pile usually introduced as a cobalt-nickel alloy. It can be put in needles and inserted in the tissue or in cylinders for cervical cancer. Its chief advantage over radium is that it can be made in large quantities at a fraction of the cost of radium.

5371 The Relationship of the Cell Surface to Metabolism. The Chemical Nature of Uranium-Complexing Groups of the Cell Surface. A. Rothstein, R. Meier, and C. Larrabee. AECD-2886, May 18, 1950, Decl. Aug. 1, 1950. 50p.

Uranyl ion forms complexes with a large variety of substances of biological interest. These can be grouped into two large classes, the organic acids and the phosphorylated compounds. In addition certain hydroxyl groups can contribute to the stability of the complexes. The stability of the uranium complexes varies widely at pH 3.5. The least stable complexes are formed by substances such as fructose and mannose which have two hydroxyl groups in the 2 and 3 position in the cis position. In the case of the organic acids, the monocarboxylic acids such as acetate are relatively unstable, whereas the dicarboxylic acids (maleic) and tricarboxylic (citrate) are relatively more stable. The proteins (albumins) owe their complex ion action to free carboxyl

BIOLOGY AND MEDICINE

groups plus accessory groups and possibly to the phosphate molecule. The stability of the protein complexes is at least as high or higher, depending on the method of calculation, as that of the citrate complex. Among the phosphate compounds, orthophosphate and phosphate esters form moderately stable complexes. Phosphate polymers such as pyro and triphosphate, adenosine triphosphate and polymerized desoxyribonucleic acid form very stable complexes. Higher polymers of phosphate such as hexametaphosphate and high molecular weight polymer form the most stable complexes of any of the substances tested. In the presence of an excess of complexing agent, the mole ratio of uranium to agent is 1 to 1 except in the case of orthophosphate and glycerophosphate in which the ratio is 1 to 3, indicating an anionic complex. In the presence of an excess of uranium, complexes with a higher percentage of uranium can be formed. In the case of egg albumin each molecule can take up 8 molecules of uranium, compared to 16 for serum albumin. Pyrophosphate, tripolyphosphate, and adenosine triphosphate can each take up two molecules of uranium. Hexametaphosphate forms a complex with a ratio of phosphorous to uranium of 3 to 1 and the high molecular weight polymer and desoxyribonucleic acid, 4 to 1. The uranium complexes with the higher polymers of phosphate have similar properties of stability (dissociation constant) and mole ratio (1 to 1) to that with the cell surface loci of yeast. The other substances tested form much less stable complexes. Other bivalent cations such as Ba^{+2}, Ca^{+2}, Be^{+2}, Mg^{+2} and Zn^{+2} can compete with uranyl ion for the cell surface loci. Na^{+} and K^{+} do not. The data presented are consistent with the hypothesis that uranyl ion inhibits sugar metabolism by forming relatively undissociated complexes with polyphosphates (possibly replacing Ca^{+2} or Mg^{+2}) which are necessary for the phosphorylation of sugar at the surface of the cell. The phosphorylation system is presumably part of a mechanism for the active transport of sugars into the cell. 40 references. (auth)

5372 Metabolism of C^{14}-Labeled Urea in Mice. A. Baird Hastings, Wright Langham, Robert E. Carter, and Lloyd J. Roth. AECU-859, nd. 15p.

Carbon-labeled urea has been injected intravenously into mice and the excretion of $C^{14}O_2$ in the expired air determined. Normal mice convert urea carbon to CO_2 at the rate of about 10% of the urea in the body per hour. Gastrectomized mice excrete urea carbon as CO_2 at about half this rate. Removal of the stomach and intestinal tract practically eliminates the excretion of urea carbon as CO_2. Removal of the kidneys causes the excretion of urea carbon as CO_2 to continue at a high rate for as long as 12 hr. It is concluded that urease of the gastrointestinal tract, rather than intestinal bacteria, is primarily responsible for the conversion of urea to CO_2 and ammonia, and that this reaction may be important for hydrochloric acid formation. 11 references. (auth)

5373 Absorption and Translocation of Radioactive 2,4-DI by Bean Plants as Affected by Cosolvents and Surface Agents. John W. Mitchell and Paul J. Linder. Science 112, 54-5(1950) July 14.

Controlled amounts of 2,4-dichloro-5-iodophenoxyacetic acid(2,4-DI^{131}) and the morpholine salt of 2,4-DI^{131} were applied to the primary leaves of bean plants and the radioactivity of other parts of the plants was determined after a 3-day interval. The greatest portion of both the acid and

salt absorbed were found in the first internode, that part of the main stem just below the primary leaves, and lowest concentrations were found in the roots. Addition of a co-solvent, Tween 20, increased the absorption and translocation, raising the amount of salt moved to the roots by 71%, an effect of interest in connection with the use of 2,4-D in killing deep-rooted perennial weeds.

5374 Chemistry and Physiology of Thyroid Hormone. William T. Salter. In the Hormones. Vol. II, p. 272-86. Gregory Pincus and Kenneth V. Thimann, Eds. N. Y., Academic Press, 1950.

The use of radioiodine in studies of the chemistry and physiology of the thyroid is reviewed, and reference is made to recent therapeutic applications.

5375 A Contribution to the Study of the Distribution of Colloidal Radioactive Gold (Au^{198}) in the Organism after Intraperitoneal Injection. A. Jentzer and P. Wenger. Rev. Med. Liege 5, 425-8(1950) Aug. 1 (in French).

From the point of view of insolubility, particle size, radiation (0.97 Mev β and 0.44 Mev γ), purity, and half-life (65 hr), colloidal radioactive gold has many advantages for the treatment of malignant tissue. The authors describe the treatment of a case of inoperable ovarian cancer, with ascite, into which was injected 600 mc Au^{198}. The amount of radioactive gold in various tissues was analyzed by two methods: (1) radiographs and (2) chemical analysis combined with the use of a Geiger counter for each organ. The activity of various organs 5 days after injection is shown and conclusions regarding the effectiveness of radioactive gold in ovarian cancer are drawn.

5376 Determination of Renal Clearance of Radioiodine. Joseph Berkson, F. Raymond Keating, Jr., Marschelle H. Power and William M. McConahey. J. App. Physiol. 2, 522-9(1950) Mar.

The equations describing the fate of ingested radioiodine (I^{131}) in the plasma and urine are solved and calculations based on the solutions are made for 40 patients, including euthyroid, hyperthyroid, and hypothyroid cases.

5377 Metabolism and Excretion of Estrone Sulfate Labeled with Radioactive Sulfur (S^{35}). M. Edward Davis, F. Ellis Kelsey, Nicholas W. Fugo, James E. Loucks, Edwin N. Horner, and Patricia Voskuil. Proc. Soc. Exptl. Biol. Med. 74, 501-5(1950) July.

Three types of experiments were performed. In the first, 4 rats were injected intravenously with radioactive estrone sulfate. The second group of experiments consisted of 10 animals. In this group the labeled hormone was administered subcutaneously and the animals sacrificed 17 hr later. In both groups selected tissues were analyzed for total radioactivity and extracted for radioactive estrone sulfate. In a third experiment 10 animals received a single subcutaneous injection of varying doses of the radioactive hormone. In these animals the urinary and fecal excretion of total and estrone sulfate radioactivity was determined. The following results were obtained: (1) Radioactive estrone sulfate shows no definite localization in any of the target organs following intravenous or subcutaneous injection into mature female rats in spite of marked estrogenic response. (2) Estrone sulfate is rapidly hydrolyzed in the body. (3) Estrone sulfate

is excreted not only by way of the urinary tract, but considerable amounts find their way into feces.

5378 The Phosphorus Metabolism of the Brain. R. M. C. Dawson and D. Richter. Proc. Roy. Soc. (London) 137B, 262-67(1950) July 25.

A similar article by the same authors was published in J. Physiol. 109, 21P-22P(1949) Sept. and was listed in Nuclear Science Abstracts as Abstract 4-3375.

5379 Potassium Uptake of Normal and Low Potassium Human Red Corpuscles. H. Gosta Davidsen and Kaj Kjerulf-Jensen. Proc. Soc. Exptl. Biol. Med. 74, 477-80(1950) July.

Radioactive potassium (K^{42}) was added to blood samples from nonhypopotassemic persons and from one case of severe persisting hypopotassemia. In some cases the plasma potassium concentration was raised by addition of KCl. The potassium exchange increased with increasing plasma potassium concentration and approached a constant level at concentrations above 9 meq/l . In an experiment with low potassium erythrocytes from the case of persistent hypopotassemia in which the plasma potassium concentration was raised, the potassium uptake (K-influx) was found to be increased by 40% of the corresponding values for normal erythrocytes. This increase in the K-influx corresponded quantitatively to a demonstrated net transport of potassium into the low potassium red blood cells. The simultaneous emigration of K-ions, however, was not reduced, and therefore the net transport of potassium emigration from the cells. The low potassium concentrations of the erythrocytes in this particular case seemed to reflect the potassium depletion of the body cells. (auth)

5380 Radioactive Iodine Uptake in the Hypermetabolism of Acromegaly. E. P. McCullagh, A. Gold, and J. B. R. McKendry. J. Clin. Endocrinol. 10, 687-91(1950) July.

The uptake of test doses of radioactive iodine in 7 cases of acromegaly with hypermetabolism was found to be low or normal. This finding contrasts with the high radioactive iodine uptake in cases of hyperthyroid hypermetabolism, when measured by the same technique, and is adduced as further evidence of the existence of an extra-thyroidal metabolic stimulus in acromegaly. 13 references. (auth)

5381 A Study at the Elimination of Radiophosphorus in Certain Neoplastic States. Andre Herve and Jean Govaerts. Acta Clin. Belg. 5, 157-67(1950)(in French).

Study of the urinary excretion of P^{32} injected intravenously in several types of diseases has given the following results: Leukemic patients generally excrete about 13% of the injected amount in 3 days and 20% in 6 days. Patients with lymphosarcoma excrete 13.5% in 3 days and 21.5% in 6 days. Retention is more marked in generalized forms. In patients with Hodgkin's disease excretion is 31% at the 3rd day and 41.7% at the 6th day. Retention is the highest in generalized forms of the disease. Treatment of lymphosarcoma and of Hodgkin's disease with P^{32} does not give the favorable results observed in leukemia and polycythemia. (auth)

BIOLOGY AND MEDICINE

5382 Sulfur Metabolism in Alfalfa. Moyer D. Thomas, Russel H. Hendricks, and George R. Hill. Soil Sci. 70, 19-26(1950) July.

In tracer experiments with alfalfa the concentration of radiosulfate in sulfur-deficient leaves reached a maximum in 16 days, then fell off as the plants grew. The sulfate was converted gradually but, after 34 days, almost completely into organic form. When harvested plants were treated with radiosulfur, the new growth took up much larger amounts of radiosulfur, and transformation to organic form was rapid. No sulfate in the roots was changed into organic form unless top growth was present. A translocation experiment showed that the radiosulfate could be absorbed through the ends of the stems dipped in a solution of radiosulfate. The absorbed sulfate was translocated down the stem and changed steadily into organic form. Some passed down through the crowns or roots and appeared in the leaves of undipped stems on the same plant, where it was also changed to organic form. (auth)

5383 Sulfur Studies of Indiana Soils and Crops. B. R. Bertramson, Maurice Fried, and Samuel L. Tisdale. Soil Sci. 70, 27-41(1950) July.

Alfalfa plants were grown in a large glass chamber with their roots effectively sealed off from the atmosphere of the aerial portion of the plants. The aerial portion was exposed to SO_2 containing S^{35}. After 48 hr, the S^{35} was detected in the nutrient solution of the roots, indicating that the SO_2 had entered the leaves and permeated the entire plant. The S^{35} was removed from the atmosphere of the aerial portion of the plants, and the nutrient solution was changed then and at daily intervals thereafter. Ten days later the plants were harvested. The different sulfur fractions of the plants were tested for radioactivity. The results, summarized in a table, show that the SO_2 was metabolized in the plant. Both soluble and insoluble organic fractions showed high counts as compared to the count found in the inorganic fraction. (auth)

5384 The Uptake of Radioactive Iodine by the Thyroid Gland of Leukemic Patients. Edwin C. Albright, and William S. Middleton. Blood 5, 764-6(1950) Aug.

Fifteen leukemic patients were given orally 100 μc of carrier-free I^{131} under fasting conditions. The uptake of the radioactive iodine was measured by external counting at a uniform, fixed distance (10 cm) over the thyroid gland 24 hr after administration of the tracer. The in vivo count so obtained was compared to an in vitro count of 100 μc of the same stock of radioactive iodine counted under identical conditions. Fourteen patients were found to have a normal iodine uptake. In 10 of these the basal metabolic rate was elevated, in 2 it was normal and in 2 it was not determined. One case showed an iodine uptake in the equivocal range with a basal metabolic rate of plus 40.

CHEMISTRY

5385 Detection of Trace Amounts of Radioactive Materials. P. R. Fields and G. L. Pyle. AECD-2876, June 7, 1950, Decl. June 29, 1950. 15p.

Some general considerations in determining micro quantities of radioactive isotopes are discussed. Uranium is chosen as an example of a typical alpha emitter and I^{131} as an example of a typical beta emitter. A hypothetical unknown solution is analyzed for uranium. Use is made of the fluorophotometric method which takes advantage of the fluorescence of uranium compounds when fused with sodium fluoride. Quantities as low as 10^{-7} mg of uranium can be detected in this fashion. In order to illustrate the problems of analysis based on alpha counting a radiochemical method is described. Both direct evaporation and iron carrier can be used to concentrate the uranium from the solution. Due to the seriousness of "self-absorption" when counting alpha particles, the uranium is purified from inert materials by solvent extraction using methyl isobutyl ketone or diethyl ether as the solvent. The differential alpha pulse analyzer is then employed to determine the number of uranium alpha particles in the possible presence of other alpha emitting elements. This instrument, used to determine the relative quantity of various alpha particles being emitted from a sample, analyzes them on the basis of their different energies. Some of the problems encountered in analyzing for beta emitting isotopes are illustrated by isolating I^{131} from the hypothetical solution. The I^{131} is isolated by adding natural iodine to a concentrated sample of the solution, oxidizing the iodine to periodate to insure isotopic exchange between the radioactive and the natural iodine, and eventually purifying the iodine by a carbon tetrachloride extraction. The purified iodine is precipitated as AgI, and counted. The recorded count must be corrected for counter geometry, backscattering of the I^{131} betas, absorption in the sample, absorption in the air and in the counter tube window. To be certain that the betas being emitted from the AgI are I^{131} betas, an absorption and a decay curve is plotted. (auth)

5386 The Colorimetric Determination of Cyanide in Industrial Wastes by Phenolphthalein. Kenneth Rohde and H. Gladys Swope. AECD-2878, June 6, 1950, Decl. June 29, 1950. 1p.

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The color producing reaction of cyanide with copper and phenolphthalein in basic solution is presented as a method for the determination of cyanide in industrial waste solutions. A photometer with a green filter is used to measure the concentration of the phenolphthalein produced in the reaction. Detailed procedures are given for the determination of both free or uncomplexed cyanide and total cyanide in plating waste or similar solutions. The precision of the free cyanide determination is demonstrated at a sample concentration of about 26 ppm, $\sigma = 4\%$. Each of these methods should be reliable at about one-fifth of these concentrations. The interferences due to beryllium, cadmium, calcium, copper, gold, iron, magnesium, nickel, silver, sodium, thorium, uranium, and zinc are outlined. The powerful interferences due to nickel and copper are most significant in an industrial waste analysis, but the effect of these interferences is eliminated by use of the procedure for total cyanide. (auth)

5387 Sample Temperature in the Carrier-Distillation Arc. S. Wexler. AECU-871, nd. 8p.

Sample temperatures during arcing in the carrier-distillation procedure have been determined by thermocouple and optical pyrometer methods. Synthetic U_3O_8 charges with added carrier show a steady state temperature range of 1300-1400°C, and about 1100°C without carrier. (auth)

CHEMISTRY

5388 Procedure for the Radiochemical Analysis of Astatine in Biological Material. Warren M. Garrison, Jeanne D. Gile, Roy D. Maxwell, and Joseph G. Hamilton. UCRL-741, May 1950. 9p.

Procedures for the radiochemical analysis of At^{211} in biological material are described. Organic substances can be destroyed by perchloric acid-nitric acid digestion without loss of astatine by volatilization. Astatine may be isolated for alpha counting from a 3N perchloric acid solution of the oxidation product by: (1) co-precipitation with metallic tellurium or (2) deposition on silver foil. Both procedures may be used for quantitative analysis. The silver foil method, however, is simpler, requires less time and is more easily adapted to routine determinations where large numbers of tissues are to be analyzed. (auth)

5389 Detection of Tritiated Compounds in Paper Chromatography. Irving Gray, Saburo Ikeda, A. A. Benson, and David Kritchevsky. UCRL-743, June 5, 1950. 7p.

A windowless tube has been developed which can be used to detect tritium radiations on paper, glass, and alumina. The counting apparatus consists of a windowless Scott tube, a gas flow regulator, and a source of helium saturated with alcohol at 0°C. The tube is wrapped in lead foil to minimize background radiation and to add ballast, so that a constant resistance to gas flow through the paper is maintained. The detection of tritiated compounds in paper chromatography is greatly simplified by the use of this device.

5390 The Hypophosphorous Acid Deamination of Diazonium Salts in Deuterium Oxide. Elliot R. Alexander and Robert E. Burge, Jr. J. Am. Chem. Soc. 72, 3100-3 (1950) July.

The deamination of benzenediazonium chloride and m-nitrobenzenediazonium chloride with hypophosphorous acid in a solution of water and deuterium oxide can be used for the introduction of a deuterium atom into a benzene ring. The yields are of the order of 40-50% but the efficiency of the reaction is poor since hydrogen is introduced 2-6 times as fast as deuterium. (auth)

5391 Harnessing Fluorine. Frederick Kurzer. Discovery 11, 42-7(1950) Feb.

This brief account of fluorine chemistry deals mainly with the fluorocarbons, their sudden rise in importance due to their ability to contain the UF_6 of the gaseous-diffusion process, and their peculiar properties which are finding applications in many different fields.

5392 The Erosion of Graphite by High Temperature Helium Jets. L. Green NAA-SR-77, May 24, 1950. 21p.

The action of a heated helium jet upon a machined graphite surface was investigated. Tests with the gas and the surface heated to 2000°C revealed that once the loosely bound particles smeared into the surface during the machining operation were blown free, no further erosion was apparent provided the helium was free of oxygen and entrained particles. (auth)

5393 Chromatographic Technology in Radioisotope Separation. I. Chromatographic Equipment. Dr. H. Weil. Atomics (London) 1, 230-4(1950) Aug.

CHEMISTRY

A review of recently designed types of chromatographic equipment is given, and three types of chromatographic apparatus are discussed. These are the pressure flow radial separator, combination columns built in sections to facilitate removal of chromatogram bands, and what may be called a chromatographic repetition separator which produces many chromatograms within the same column or radial separator. It is claimed that practically continuous large scale chromatographic separation and isolation are possible with the use of the new chromatographic equipment.

5394 A Magnetically Operated Blood Cell Pipette Shaker. C. Sanders, K. C. Parry, A. E. Bennett, and J. C. H. Geisow. Atomic Energy Research Establishment. Report AERE-MED/R-536, May 1950. 5p.

A magnetically operated blood cell pipette shaker is described. The shaker holds up to eight pipettes at one time in two rows of four. The pipettes are shaken vigorously in a vertical plane and at the same time rotate rapidly. The use of perforated "rubber policemen" in order to prevent fluid loss from the pipettes is described. The chief advantage of this shaker is its inexpensiveness. (auth)

5395 A Simple Temperature Controlled Laboratory Furnace. R. S. Barnes. Atomic Energy Research Establishment. Report AERE-M/R-378, Apr. 1950. 13p.

The heating element of the furnace is a platinum winding in series with a nickel-chromium winding, and with two external ratio arms it forms a Wheatstone bridge network which is supplied from the a-c mains. This bridge is balanced at a temperature determined solely by the setting of the ratio arms, provided that certain conditions are fulfilled. The out-of-balance voltage from the bridge, after amplification by an audio-frequency transformer with a tuned secondary, drives a small thyratron which operates a thermal switch controlling the bridge current so that the bridge is kept in balance. For six months the apparatus has given satisfactory service at temperatures up to 800°C. In a run at 750°C the temperature was maintained constant to ±0.1°C for a day. The device should prove useful in many fields on account of its reliability, robustness, and extreme simplicity both in operation and construction. (auth)

5396 Determination of Cerium. Photometric Method with Radiometric Correction. Arthur J. Freedman and David N. Hume. Anal. Chem. 22, 932-6(1950) July.

A rapid method has been developed for the estimation of small amounts of cerium in mixtures of rare earths and other elements, based upon a separation of part of the cerium in pure form, followed by a spectrophotometric determination of the cerium and a measurement of the efficiency of the recovery process with a radioactive tracer. The procedure takes about 4 hr, and under the conditions used is accurate to about 1.8%. A method of counting radioactive liquid samples with an end-window Geiger tube to a reproducibility of better than 0.5% is reported. Applicability of the combined photometric-radiometric technique as a general method for determination of trace amounts is discussed. (auth)

5397 The Phosphates and Polyphosphates of the Rare Earths and Thorium. A. G. Buyers and L. F.

CHEMISTRY

Audrieth. University of Illinois, Mar. 15, 1950. 41p. (AEC File No. NP-1435.)

A study has been made of the phosphates and polyphosphates of the rare earths and thorium using a number of different experimental approaches in order to characterize more definitely the chemical composition of these materials as well as their properties. Three experimental procedures have been employed involving: (1) The so-called hydrogen-ion-displacement procedure which was used effectively in the case of the rare earths. (2) A combined pH and conductometric procedure which was used both for the rare earths and thorium. (3) Gravimetric methods for the purpose of determining the composition of a number of phosphate and polyphosphate precipitates. These studies have disclosed that the normal orthophosphates of the rare earths and thorium are precipitated when the respective ions are allowed to react in aqueous solution. It has also been shown that normal pyro- and triphosphates of the rare earths precipitate when solutions of rare earths and the respective polyphosphate ions are adjusted to a pH of 4.5. Back-titration of the liberated hydrogen ion indicates that the resulting products, despite their gelatinous and obviously hydrated nature, consist essentially of the pyrophosphate and triphosphate. Most significant are the findings which have to do with the formation of polyphosphate complexes of the rare earths and of thorium. The ortho-, pyro-, and triphosphates precipitate the rare earths and thorium completely over definite pH ranges (around 4.5 for the rare earths and between 1 to 3 for thorium). It is important to note that the rare-earth precipitates go into solution on addition of excess of pyrophosphate reagent at a pH of about 8 and above a pH of 7 when excess triphosphate is used. In the case of thorium, a soluble complex with pyrophosphate is formed at a pH above 7 and with triphosphate at a pH above 5. The exact nature of these polyphosphate complexes has not yet been determined. Consideration of these facts indicates that it should be possible to effect separation of thorium from the rare earths by precipitation of the thorium at a pH of 1. This could be done using either aqueous triphosphate or pyrophosphate as precipitants or by formation of soluble complexes of thorium at a pH above 5, under which conditions the rare earths form insoluble triphosphates. 33 references. (auth)

5398 Design of Ether-Water Contacting System. Final Report. J. B. Tepe and W. K. Woods. AECD-2864, Jan. 18, 1943, Decl. May 19, 1950. 82p.

Tests were conducted on the counter-current flow of isobutyl alcohol and water in a 9-in. diameter sieve-plate column. By increasing the free area of the plates to 15% of the cross section of the column and by decreasing the plate spacing to 1½ in., it was found that the liquids could be contacted and separated with a time of passage of less than 4.25 seconds per actual stage, the efficiency of the contacting not being known. On the hypothesis that adequate contacting could be obtained by pumps or otherwise, a study was made of essentially simple methods of separating an isobutyl alcohol-water emulsion. By plant visits and literature studies information was obtained relative to other types of equipment. In particular it was concluded that centrifuges would separate an emulsion satisfactorily with low contact time but that the cost was prohibitively high. Both pumps and jet contacting devices appeared worthy of further study, but most other types of contactors involved too great retention times. (auth)

5399 The Absorption Spectrum of Element 61, Promethium. G. W. Parker and P. M. Lantz. J. Am. Chem. Soc. 72, 2834-6(1950) July.

The absorption bands of promethium in the visible spectrum are observed to resemble those of neodymium, both in number and in intensity but are distinctly separable from the neodymium bands by at least 8 mμ. The bands are in the same position and of the same magnitude for both the chloride and nitrate solutions. The most prominent absorption bands for a solution of promethium are to be found in positions 493.5 ± 0.5 mμ, 548.5 ± 0.5 mμ, 568.0 ± 0.2 mμ, 685.0 ± 0.1 mμ, 702.7 ± 0.3 mμ, 737.2 ± 0.2 mμ, and 785.0 ± 0.1 mμ. (auth)

5400 Preparation of Labeled Zinc Lactate from Propionic Acid. D. M. Hughes, R. Ostwald, and B. M. Tolbert. UCRL-704, May 31, 1950. 10p.

Zinc lactate-1-C^{14}, zinc lactate-2-C^{14} and zinc lactate-3-C^{14} have been prepared in yields of 76-87% based on labeled propionic acid. Details of this preparation for a 6-12 m mole scale are described. (auth)

5401 Synthesis of Potential Cancer-Inhibiting Agents. I. 2,6-Diamino-[3′,2′-h]-Thiazolinopurines. Maxwell Gordon. UCRL-740, June 1, 1950. 20p.

The following new derivatives of 2,6-diaminopurine have been prepared: 8-mercapto-, 8-acetonylmercapto-, 8-carboxymethylmercapto-, and 8-carbethoxymethylmercapto-2, 6-diaminopurine. The synthesis of 2,6-diamino-4′-methyl-[3′,2′-h]-thiazolinopurine is described and a route to 2,6-diamino-[3′,2′-h]-thiazolinopurine is indicated. 2,6-Diamino-8-hydroxypurine has been prepared by an improved procedure. Ultraviolet spectra of the above compounds have been measured in acid, neutral, and alkaline solutions. 24 references. (auth)

5402 A Note on the Synthesis of C^{14}-Carboxyl-Labeled Salicylic Acid. H. George Mandel and Paul K. Smith. J. Am. Pharm. Assoc., Sci. Ed. 39, 479(1950) Aug. (Note).

A description of the synthesis of C^{14}-carboxyl-labeled salicylic acid starting with 2 gm (0.010 mole) of barium carbonate containing 0.5 μc radioactive carbon is given. The total yield was 0.94 gm (68%) salicylic acid.

5403 Preparation of I^{131} Labelled Iodoacetamide and N-Iodoacetyl Amino Acids. Orrie M. Friedman and Alexander M. Rutenburg. J. Am. Chem. Soc. 72, 3285-6(1950) July (Note).

Labeled iodoacetamide, to be used in tumor studies, was obtained by heating chloroacetamide and NaI^{131} in acetone solution under reflux. After removal of NaCl and acetone, the residue, dissolved in ethyl acetate and benzin, was crystallized out as the product. Labeled N-iodoacetyl L-tryptophan was obtained from chloroacetyl L-tryptophan and NaI^{131} in acetone solution, heated under reflux. After filtering off the NaCl, water was added to the solution, then partially evaporated and cooled to precipitate the product.

CHEMISTRY

5404 Applications of the Radioactive Tracers. A. G. Maddock. Anales real soc. espan. fis. y quim. 56, 269-78(1950) Apr. (in Spanish).

A discussion of the techniques of using radioactive tracers is presented. It is based on the following 5 classifications: (1) experiments which utilize the great sensitivity of methods of detection and determination of radioactive substances, (2) applications in which the radioactivity of the tracer atoms makes possible the distinction of those groups which are chemically identical, (3) experiments in which the quantity of one substance is determined by the diminution of specific activity, the mixing with a radioactive form of the same substance, (4) procedures for revealing the location of those radioactive substances which depend on the penetrating properties of the radiations, and (5) the measure of time for the disintegration of radioactive materials.

5405 The Reactions of Uranium Oxides and Liquid Nitrogen Tetroxide. George Gibson and Joseph J. Katz. AECD-2877, June 5, 1950, Decl. June 29, 1950. 10p.

Liquid nitrogen tetroxide reacts with uranium oxides at 25°C and 1.2 atmospheres to form uranyl nitrates containing varying quantities of nitrogen tetroxide. The anhydrous oxides, such as UO_3, (Mallinckrodt, red and active forms) and U_3O_8 react slowly and only partially to yield $UO_2(NO_3)_2 \cdot 2NO_2$. The dihydrates, $UO_3 \cdot 2H_2O$ and $UO_4 \cdot 2H_2O$ react rapidly and completely to form, as a limiting case, $UO_2(NO_3)_2 \cdot NO_2 \cdot 2H_2O$. This compound is unstable even in dry air, losing nitrogen tetroxide at $-42°C$ and 5×10^{-4} mm as well as at 25°C and 760 mm. The monohydrate, $UO_3 \cdot H_2O$, with nitrogen tetroxide behaves like the dihydrates. Analytical data indicate a compound of the composition $UO_2(NO_3)_2 \cdot 2NO_2 \cdot H_2O$. All of these nitrogen tetroxide containing uranyl nitrates are sensitive to moisture and lose nitrogen tetroxide readily on contact with moist air or water. (auth)

5406 Chemistry of Aqueous Uranium (V) Solutions. III. The Uranium (IV)-(V)-(VI) Equilibrium in Perchlorate and Chloride Solutions. F. Nelson and K. Kraus. AECD-2879, June 12, 1950, Decl. June 29, 1950. 17p.

The equilibrium constant K_{eq} for the reaction

$$2UO_2^+ + 4H_3O^+ \rightleftharpoons UO_2^{+2} + U^{+4} + 6H_2O$$

was obtained as a function of ionic strength for perchlorate and chloride solutions using polarographic, spectrophotometric and potentiometric methods. A modified Debye-Huckel expression was found to represent the data up to $\mu = \sim 1.0$ and the activity constant

$$K^0_{eq} = K_{eq} \frac{\gamma_{UO_2^{+2}} \gamma_{U^{+4}}}{\gamma^2_{UO_2^+} \gamma^4_{H_3O^+}} = (1.7 \pm 0.3) \times 10^6$$

was evaluated.

The stability constant of the uranyl chloride complex UO_2Cl^+

$$K^0(VI)_c = \frac{(UO_2Cl^+)\, \gamma_{UO_2Cl^+}}{(UO_2^{+2})(Cl^-)\, \gamma_{UO_2^{+2}}\, \gamma_{Cl^-}} = 2.4$$

was estimated from a comparison of K_{eq} for chloride and perchlorate solutions. Some observations on the polarography of uranium (V) and uranium (VI) have been included. The diffusion current constants of uranium (VI) and the ratio of the diffusion current constants of uranium (V) and (VI) were evaluated as a function of ionic strength. 14 references. (auth)

CHEMISTRY

5407 The Magnetic Properties of Uranium and Uranium-Iron Alloys. L. F. Bates and J. R. Mallard. Proc Phys. Soc. (London) 63B, 520-6(1950) July 1.

Measurements have been made of the magnetic susceptibility of fairly pure uranium and of 5 and 10 atomic % alloys of iron with uranium. Using a modification of the Curie method, with special pole-pieces and electromagnetic dynamometer control, the specimens were found to be paramagnetic with no trace of ferromagnetism in the temperature range 20-350°C. At 20°C the susceptibility of pure uranium is $+1.740 \times 10^{-6}$ emu per g, increasing to $+1.804 \times 10^{-6}$ at 350°C; the results fit the equation

$$\chi_U = 32 \times 10^{-11}T + 1.564 \times 10^{-6} + 24.0 \times 10^{-6}/T$$

Assuming that the iron is present in form of the compound U_6Fe, it is found that the latter has a susceptibility of $+2.036 \times 10^{-6}$ emu per g at 20°C, which remains practically constant with temperature.

ENGINEERING

5408 Fifteenth Informal Monthly Report on Heat Transfer and Pressure Drop of Air Flowing in Small Tubes. J. N. Addoms and C. L. Kroll. NEPA-1138, Aug. 1949. 4p.

A brief review of the status of the work on single and multiple drilled-plates and electrically heated tubes is presented.

5409 Vacuum Equipment for the 4-Mev Linear Electron Accelerator. B. G. Loach. Atomic Energy Research Establishment. Report AERE-E1-R-229, Mar. 10, 1949. 51p.

This report describes the vacuum system of the 4-Mev linear electron accelerator, including the self-contained pumping tables, and the automatic-control equipment. An account is given of development work on the diffusion pumps and vacuum gauges and the design of high-vacuum shut-off valves. Operating instructions and numerous diagrams are included. (auth)

MINERALOGY, METALLURGY, AND CERAMICS

5410 The Metallography of Zirconium. H. P. Roth. AECD-2882, June 9, 1950, Decl. July 6, 1950. 9p.

This report describes the method used (a variation of the perchloric acid technique) to electropolish zirconium samples and its alloys. Numerous photomicrographs are included.

5411 The Extrusion of Beryllium. E. C. Creutz, D. G. Gurinsky, J. H. Chapin, R. W. Yancey, F. G. Foote, H. Bethke, and A. R. Kaufmann. AECD-2883, Jan. 1946, Decl. Aug. 2, 1950. 29p.

A method for the extrusion of beryllium into rods and tubing has been developed. The operation is carried out between 1500 and 1900°F and the billet is clad in a layer of soft iron to prevent contact between it and the die steels.

Extruded beryllium has much more strength and ductility than cast metal due to the crystal refinement which occurs as a result of the fabrication operation. It is believed that the extrusion of beryllium into round or rectangular shapes or into tubing can be accomplished on a commercial scale and the resulting material is sound and slightly ductile. 11 references. (auth)

5412 Second Quarterly Report (Mar. 1, 1950 - May 31, 1950) Preparation of High Purity Magnesium and a Study of the Effect of Non-Metallic and Alkali Metal Impurities on the Corrosion Characteristics of Pure Magnesium. The Dow Chemical Company. COO-14, nd. 35p.

A sublimation method or a Grignard reaction to concentrate the impurities has enabled an increase in analytical sensitivities. Data on the rate of impurity elimination is being obtained by analyzing sublimation residues. The nature and extent of impurities in magnesium have been determined with greater sensitivities than previously reported. This has been accomplished by detailed analyses and studies of both single and multiple sublimates and residues. Approximately 60 pounds of high purity triple sublimed magnesium has been produced to be used as a base material for contamination studies. In this magnesium all impurities normally analyzed for have been reduced below spectrographically measurable quantities with the exception of Ba and Ca. The effects of exposure time, NaCl concentration, alternate immersion vs stagnant immersion and machining vs aloxiting specimens on the corrosion rate of high purity magnesium and a high purity alloy (AZ31 alloy) have been investigated. (auth)

5413 Welding of Tantalum Tubing. N. A. Chapin and W. D. Egnor. EAH-130, Mar. 2, 1950. 16p.

Tantalum tubing may be satisfactorily welded by the Inert-Arc process using helium. A flanged joint with a flange height of approximately 1.5T appears to be very suitable to obtain no surface oxidation and complete fusion. The physical properties of a welded sample are approximately those of annealed tantalum. (auth)

5414 Self-Diffusion of Metals and Associated Phenomena. B. H. Alexander, R. W. Baluffi, M. H. Dawson, H. P. Kling, and F. D. Rosi. NYO-663, May 8, 1950. 118p.

The alpha phase of the Ag-Sn system was chosen for a study of chemical- and self-diffusion rates, and preparation of diffusion couples was started. The investigation of boundary movements during diffusion in copper-brass couples and of the formation of pores in alpha brass was continued in an effort to obtain accurate measurements of dimensional changes that can be ascribed to diffusion phenomena alone. A metallographic study of the change and size of pores in copper wire compacts was made. A program was started for determining density distribution of silver powder compacts as a function of sintering time and temperature. Additional studies were started on the self-diffusion of aluminum and on the effect of lattice vacancies on diffusion rates.

An investigation of the viscous behavior of gold wires showed that solid gold can behave in a viscous manner and that the temperature variation of the effective viscosity coefficient is the same as that for self-diffusion of gold. Calibration tests were made on a newly built creep furnace preparatory to creep tests on pure silver. In a study made of microslip in coarse-grained zinc wires and of the vibration produced by plastic flow, a new system utilizing a piezoelectric crystal appeared to be the most successful. Another phase of the creep program consists of a study of the influence of grain boundaries on plastic deformation above and below the equicohensive temperature.

The rate of grain coarsening in recrystallized silver has been determined and it is shown that the temperature dependence of this process is similar to that for grain boundary diffusion in silver. The anisotropy of this kind of growth is being studied in single crystal specimens which are coated (by electroplating) with a polycrystalline layer. The rate of growth of recrystallized grains during ageing was studied in an aluminum-silver alloy. Some observations were made on veining in aluminum-silver alloys and in copper. The spheroidization studies during this interval were concentrated on fine wires on which was electroplated another metal. These systems included Cu plated with Ag, Ag with Cu, Fe with Cu, and Cu with Fe. 45 references. (auth)

5415 Zirconium and Hafnium: A Bibliography. Gordon C. Williams, E. G. Baker, Jr., E. W. Holzknecht, and R. G. Moody. NYOO-1008, May 1950. 236p.

This bibliography is the result of a thorough search of Chemical Abstracts from the date of their first publication in 1907 through 1948. It includes an almost complete listing of all references to either zirconium or hafnium appearing in Chemical Abstracts. (auth)

5416 Determination of the Temperature of Sprayed Metal Particles. James E. Cline, Robert T. Thurston, and John Wulff. Welding J. 29, 320-2s(1950) July.

This paper presents the development of an experimental technique for determining the heat content and temperature of sprayed metal particles at the moment of impact. The heat supplied by the particles to a Cu plate was matched by that from a heating coil. The investigation includes tests made with zinc, aluminum, copper, nickel, iron, and molybdenum. The results obtained indicate that the metal particles are at their melting point at impingement. Calculations are included to show that the contribution of the kinetic energy to the heat content and temperature of the particles is a negligible quantity.

5417 Metal Spraying of High-Temperature Metals and Alloys. Robert T. Thurston and John Wulff. Welding J. 29, 313-9s(1950) July.

The results of an investigation of the metal spraying of molybdenum, nickel, and high-melting-point alloys are presented in this paper. A hydrostatic bursting technique was developed as a means of measuring the strength of sprayed deposits. With this technique, a relationship was shown to exist between the oxide content and strength of sprayed metal. Sintering of sprayed metal deposits in hydrogen, especially in the presence of a liquid phase, was successfully accomplished, resulting in significant increases in density and bursting strength.

5418 Physical Chemistry of Gallium - Indium Alloys. Final Technical Report. J. Hugh Hamilton, John R. Lewis, and J. P. Denny. University of Utah, May 15, 1950. 93p. (AEC File No. 1607.)

Alloys of gallium, indium, tin, lead, and bismuth have been studied. The gallium-indium eutectic, located at 24% indium, is found to melt at 15.7°C, and the gallium-indium-

MINERALOGY, METALLURGY, AND CERAMICS

tin eutectic, determined as having the composition 62.5% Ga, 21.5% In, and 16% Sn, melts at 10.7°C. Both alloys are definitely liquid at room temperatures. The constitution of the system gallium-indium has been redetermined. Many features of the new diagram are in agreement with the previous work done on the system, but significant differences are noted with regard to the indium-rich liquidus and solid solubility field. Techniques have been developed for metallographic examination of the low melting gallium alloys, and very striking strain lines have been observed in some of the structures. Corrosion tests have been conducted on these same alloys under oxidizing conditions, to determine alloy stability. Experimental evidence shows rather conclusively that no gallium-lead-bismuth compositions are liquid at room temperatures. The genesis of phase diagrams is discussed and the various methods are coordinated on the basis of free energy, temperature, and composition relationships. (auth)

5419 Quarterly Progress Report on Alloys for High-Temperature Service. Battelle Memorial Institute, Mar. 16, 1950. 13p. (AEC File No. NP-1505.)

This report discusses some of the experiments undertaken to investigate the properties (transition temperature, thermal-shock resistance, transformation temperature ranges for some of the tungsten-and molybdenum-bearing alloys) of chromium base alloys.

5420 Research on Zirconium Alloys. Final Summary Report June 18, 1940, to October 17, 1949. F. B. Litton and S. C. Ogburn, Jr. Air Materiel Command. Report AF-TR-5943, Dec. 12, 1949. 38p.

A further determination has been made of the physical and mechanical properties of iodide zirconium. Induction melting of zirconium and zirconium alloys in vacuum using graphite crucibles and arc melting under a purified argon atmosphere in a water cooled copper crucible are compared. Iodide zirconium was found not suitable for use in air at 750°C due to poor oxidation resistance, although it might be considered for use of 400°C. Most of the binary and ternary alloys developed were found greatly inferior to iodide zirconium in oxidation resistance. Zirconium and zirconium alloys containing from 0.1 to 8.2% hafnium have been prepared. Initial results indicated that hafnium had no pronounced effect on the strength properties of zirconium. Preliminary corrosion tests have been made on both zirconium and zirconium alloys. (auth)

5421 Preliminary Experiments on Continuous Radioassay of Radioactive Ores and Mill Products. Donald W. Haney. MITG-A94, June 14, 1950. 24p.

The application of gamma counting to the continuous radioassay of radioactive ores and mill products was investigated. Pulp counting was found to be superior to counting over feed belts because of greater sensitivity and immunity from large temperature fluctuation. A radioassay tank for flowing pulp was constructed, suitable for a 100 to 350-ton mill. The assay range is from 0.006 to 0.5% U_3O_8 ore. The upper limit may be extended through the judicious use of metallic absorbers. (auth)

5422 Investigation on Indian Radioactive Minerals: II. Allanite. S. K. Nandi and D. N. Sen. J. Sci. Ind. Research (India) 9B, 124-7(1950) May.

MINERALOGY, METALLURGY, AND CERAMICS

The formula $(Ca, Ce)_2(Al, Fe, Mg)_3Si_3(O, OH)_{13}$ has been assigned to the radioactive mineral "allanite" on the basis of quantitative chemical analysis. The geological age of the mineral has been determined from the Pb, U, and Th content as 830×10^6 years. Three analysis schemes are given in detail.

5423 Isotopic Composition of the Oxygen in Silicate Rocks. Peter Baertschi. Nature 166, 112-13(1950) July 15.

Oxygen was separated from silicate rocks by chemical methods and its isotopic composition was analyzed by a Nier-type double-collector mass-spectrometer of very high sensitivity. The reasons for isotopic deviations in various rocks are discussed.

5424 U^{235} in Thucholite. J. B. Orr. Phys. Rev. 79, 401-2(1950) July 15 (Letter to the editor).

In a previous letter (Orr, Phys. Rev. 76, 155(1949)), abstracted in NSA as Abstract 3-1114, the author suggested that the lower ratio of U^{235} to U^{238} in thucholite, compared with that in other uranium sources, might be due to a former chain reaction, the carbon content acting as a moderator. New comparisons of thucholite with uraninite, made by means of fission counts induced by a moderated Ra-Be neutron source, show, however, that any real difference in the U^{235} composition must be less than 6%.

PHYSICS

5425 On the Relative Production of π^+ and π^- Mesons by Neutrons. Hugh Bradner, D. J. O'Connell, and B. Rankin. UCRL-684, May 1, 1950. 6p.

A 0.5 in. thick graphite target was bombarded with 270-Mev neutrons and the positive and negative π mesons of 50-65 Mev energy leaving the target at an angle of 90° to the incident neutrons were recorded in nuclear emulsions after passing through 0.5 in. copper absorbers. From the number of π^+-μ decays and stars produced by π^- mesons, the π^+/π^- ratio is calculated to be $1/12.6 \pm 12\%$. The results are compared with those obtained when carbon was bombarded with 345-Mev protons.

5426 The Decay of a $\tau^\pm$ Meson into $\pi^\pm$ and π_0 Mesons. H. Fukuda and Y. Miyamoto. Progress Theoret. Phys. 5, 147-8(1950) Jan.-Feb. (Letter to the editor).

Calculation of the half-life of decay of a $\tau^\pm$ meson into $\pi^\pm$ and π_0 mesons has been performed in order to compare it with that of a τ meson into 3 π mesons which has been found in photographic emulsions. Assuming that $\tau^\pm$, $\pi^\pm$ and π_0 mesons are all Bose particles and decay through virtual creation of nucleon pairs, all possible cases of meson types and couplings in both symmetrical and neutral theories have been examined. Using the coupling constants $g_\pi^2/\hbar c = g_{\pi_0}^2/\hbar c = 1/10$ and $g_\tau^2/\hbar c = 1/10^3$, the half-life of the decay of a $\tau^\pm$ meson into $\pi^\pm$ and π_0 mesons, if it is not forbidden, lies between 10^{-14} and 10^{-16} sec. Since this is much shorter than that of a 3 π decay process, the authors conclude that the τ meson does not decay to π and π_0 mesons before a 3 π decay.

5427 The Decay of a $\tau^\pm$ Meson into a $\pi^\pm$ Meson and a Photon. H. Fukuda and Y. Miyamoto. Progress Theoret. Phys. 5, 148-50(1950) Jan.-Feb. (Letter to the editor).

PHYSICS

This is a preliminary report on the lifetime decay of a $\tau^{\pm}$ meson into a $\pi^{\pm}$ meson and a photon. The matrix elements for the process consist of 3 types (depending on the meson type and the coupling chosen) which are illustrated by Feynman's diagrams. The authors select the types and couplings of τ and π mesons so that the τ meson does not decay into a π meson and a photon before 3 π decay, and such that the 3 π decay is not forbidden.

5428 The Electrons in Cosmic Rays. C. L. Critchfield, E. P. Ney, and Sophie Oleska. Phys. Rev. 79, 402-3 (1950) July 15 (Letter to the editor).

Cloud-chamber pictures, obtained at 20 g/cm² atmospheric depth with at least two ¼-in. Pb plates in the chamber, showed a number of electron showers of 1 Bev or greater. If produced by primary electrons, an upper limit of 0.2% would be deduced for the relative abundance of the latter in cosmic radiation. Comparison with air shower experiments makes it seem unlikely that primary electrons play a part, and the possibility that all the electrons observed were due to decay of neutral mesons is discussed.

5429 Excess Electrons in Lower Atmosphere and γ-decay of Neutral Mesons. S. Hayakawa. Progress Theoret. Phys. 5, 158-9(1950) Jan.-Feb. (Letter to the editor).

The electrons in the lower atmosphere cannot be explained completely by knock-on phenomena or the decay of μ mesons. A curve reflecting this difference agrees well (aside from a difference in absolute value) with that obtained by calculating the electron intensity which would result from the disintegration of a neutral π meson into 2 photons and subsequent electron production.

5430 Meson Production by X-rays. Z. Koba, T. Kotani, and S. Nakai. Progress Theoret. Phys. 5, 137-8 (1950) Jan.-Feb. (Letter to the editor).

Using the model of a pseudoscalar meson with pseudoscalar coupling and the completely relativistic perturbation method of Feynman and Dyson (Phys. Rev. 75, 486(1949)), the authors calculate the cross section for the production of π^+ and π^- mesons by x-rays. The results give $\sigma_-/\sigma_+ \approx 1.4$, in fair agreement with experiments at Berkeley. This charge asymmetry is thought to be due to the relativistic effect. The calculated angular distribution of the mesons shows little agreement with experiment. This is considered to be due to the choice of the meson type used. Means of overcoming this discrepancy are discussed.

5431 A Note on the Mixed Shower. S. Ogawa. Progress Theoret. Phys. 5, 138-9(1950) Jan.-Feb. (Letter to the editor).

It is thought that by examining the angles and energies of the soft cores starting from the origin of mixed showers in nuclear emulsions, the mass of the neutral meson can be calculated. However, the little data that exist do not give conclusive results.

5432 Note on Varitrons. S. Hayakawa. Progress Theoret. Phys. 5, 145-7(1950) Jan.-Feb. (Letter to the editor).

A short review is given of some of the data found and theories advanced to explain the origin and life of varitrons in cosmic radiation. 14 references.

PHYSICS

5433 Nuclear Transmutations Produced by Cosmic-Ray Particles of Great Energy. Part V. The Neutral Mesons. A. G. Carlson, J. E. Hooper, and D. T. King. Phil. Mag. 41, 701-24(1950) July.

The spectrum of the γ radiation in the atmosphere at 70,000 ft has been determined by observations on the scattering of pairs of fast electrons recorded in photographic emulsions exposed in high-flying balloons. The detailed form of the spectrum is consistent with the assumption that the γ rays originate by the decay of neutral mesons. It is found that the mass of the neutral mesons is 295 ± 20 m and that they are created in nuclear explosions with an "energy spectrum" similar to that of the charged π particles. A method is described for determining the lifetime of the neutral mesons and their frequency of occurrence compared with charged π particles. The lifetime, τ_{π^0} is less than 5×10^{-14} sec. It may be possible to determine the lifetime, by observations of greater statistical weight, if it is longer than 2×10^{-14} sec. The ratio of the number of neutral mesons to charged mesons, produced in nuclear explosions of great energy, is equal to 0.45 ± 0.10. 22 references. (auth)

5434 On Barometric Effects of Extended Atmospheric Showers. C. Castagnoli, A. Gigli, and S. Sciuti. Nuovo cimento 7, 307-12(1950) May 31 (in Italian).

The results of correlation measurements between extensive atmospheric showers and atmospheric pressure at 3500 m above sea level are reported. The barometric coefficients obtained are 9.8% ÷ 10.6% for a 4.7-m base and 9.2% ÷ 9.7% for a 6.9-m base.

5435 On the Dependence on Depth of the Dispersion of an Electron Shower. A. Borsellino. Nuovo cimento 7, 323-30(1950) May 31 (in Italian).

The paper values analytically the angular mean square deviation, the lateral mean square deviation, and the coupling between them, of the electrons of an air shower. The results are expressed in a compact form. A discrepancy between the results of a preceding paper and those of other authors is explained. Calculation indicates that (for electrons of a given energy) spread actually increases with depth. (auth)

5436 On the Origin of Electronic Rays with Moderate High Energy. Y. Fujimoto and S. Hayakawa. Progress Theoret. Phys. 5, 144-5(1950) Jan.-Feb. (Letter to the editor).

The energetic electronic rays in the upper atmosphere, which are measured as bursts caused by the presence of a thin lead plate, are supposed to originate mainly from high energy nuclear collisions. Several workers have proposed possible mechanisms to produce such radiation in a nuclear collision, among which the most plausible ones are the neutral meson hypothesis and charge acceleration hypothesis. In order to test these hypotheses, the authors calculate the intensity of electronic rays under each hypothesis and compare it with the result of burst experiments. However, the difference in data between various experiments is so large that the authors cannot state definitely which of the two hypotheses is the more plausible one.

PHYSICS

5437 On the Production of Penetrating Showers in Lead and Carbon. L. Mezzetti and R. Querzoli. Phys. Rev. 79, 168-9(1950) July 1 (Letter to the editor).

A counter telescope was arranged to record single particles entering within a small solid angle and producing two or more particles, in 46 g/cm² Pb or 17g/cm² C, which would then penetrate 7.5 cm Pb. A curve is plotted for frequency of events versus number of shower particles. The ratio of the mean free paths for generation of penetrating showers (in g/cm²) was found as $\lambda_{Pb}/\lambda_C = 4.4 \pm 1.0$.

5438 The Penetration of Particles Associated with Cosmic-Ray Stars. C. G. Montgomery, D. D. Montgomery, and J. A. Northrop. Phys. Rev. 79, 293-6(1950) July 15.

A survey was made at Climax, Colorado (elevation 3510 m) of the particles associated with nuclear explosions or stars, which were capable of emerging from the thin-walled ionization chamber in which the stars were recorded and penetrating various thicknesses of lead absorber. The experiment was so designed as to distinguish between electrons and penetrating particles. It was found that in a small fraction of the nuclear events (1 to 2%) there were associated electrons. In some of these events there were pairs of associated rays capable of penetrating 8 in. of lead placed below the chamber. The absorption in lead was found to be exponential with a mean free path of 107 ± 30 g/cm. (auth)

5439 The Proportion of Meson Tracks Recorded in a Nuclear Emulsion C_3 + B Exposed to Cosmic Rays. Hassan Moucharafyeh, and Simone Reband. Compt. rend. 230, 2285-6(1950) June 26 (in French).

A study of the energy spectrum of tracks due to particles other than mesons, in an Ilford C_3 + B plate exposed at an altitude of 4500 m, confirms that the proportion of mesons of all the visible tracks is 2 to 3%. (auth)

5440 Magnetic Amplifier Voltage Regulator. John L. Wolff, Jr. AECD-2851, Jan. 20, 1950, Decl. Apr. 12, 1950. 25p.

This report discusses the development and testing of a regulated power supply which uses a magnetic amplifier as the regulating element. Circuitry considerations for a simple regulating system are presented and applied to the magnetic amplifier regulating system. The performance of the regulated power supply is described and has been found to be very satisfactory for general electronic supply purposes. (auth)

5441 Instrument Research and Development. Quarterly Progress Report for Period Ending April 15, 1950. W. E. Thompson. ORNL-714, June 19, 1950. 34p.

The following topics are included: A method for regulating adjustable high voltage power supplies; Portable fast neutron dosimeter; Portable alpha survey meter; Cockroft-Walton generator; Magnet analyzer; Hydrogen pumping with oil diffusion pumps; Diffusion pump protector; Ion gauge control; Thorium and uranium hydrides; Reasonance analyzer; Current integrator; Logarithmic electrometer; Radiation detector engineering; Side window mica window counter tubes; Liquid level telemeter; Thermistor temperature recorder for meteorological survey; Microformer extensiometer for creep measurements; Universal strain gauge bridge control unit; a-c recording hydrometer; Crystal growing instrumentation and control; Agar counting; Modification of atomic instrument company scalers; Instrument construction and maintenance; Electron energy studies with anthracene scintillation spectrometer; Single channel differential pulse height selector; A multi-channel pulse sorter.

5442 The Automatic Control of Electrode Potential. G. C. Barker. National Research Council of Canada. Report CRC-440, Apr. 26, 1950. 24p.

The factors influencing the design of an automatic control circuit are discussed, and a circuit which has application to a wide variety of problems is described. The instrument is a general purpose type, providing continuous control of the potential with an accuracy of about 0.1 mv over short periods of time so long as the voltage between the polarizing and experimental electrodes does not change by more than 1.0 volt. Over long periods of time (hours), with the same proviso, the potential will not change at a greater rate than 0.5 mv/hr. The possible applications of this control circuit are outlined.

5443 Precision Thermostat for High Temperatures. Natl. Bur. Standards (U.S.) Tech. News Bull. 34, 105-7(1950) Aug.

A short description is given of a precision thyratron thermostat for automatic control of furnace temperatures. The furnace winding serves as a resistance thermostat and constitutes one arm of an a-c bridge which, through an amplifier, controls the firing period of a 3D22 thyratron tube. When the tube fires, the bridge current, and thus the current through the furnace, is increased.

5444 The New Element Berkelium (Atomic Number 97). Stanley G. Thompson, Albert Ghiorso, and Glenn T. Seaborg. AECD-2880, Apr. 26, 1950, Decl. July 20, 1950. 35p.

An isotope of element 97 (berkelium, symbol Bk) has been produced and identified. This isotope probably has the mass number 243 as produced in the reaction $Am^{241}(\alpha,2n)Bk^{243}$. It decays predominantly by electron capture with a half-life of 4.6 ± 0.2 hr and exhibits ~ 0.1% alpha-particle decay branching. The alpha particles are of three groups, the maximum energy being 6.72 Mev (30%). The other two energy groups are 6.55 Mev (53%) and 6.20 Mev (17%). The bombardments were made with 30- to 35-Mev helium ions in the Berkeley Crocker Laboratory 60-in. cyclotron. The chemical separations were made using a combination of precipitation methods and high temperature ion exchange columns with Dowex-50 resins. The growth of a curium isotope decaying by the emission of alpha particles of energy 5.84 Mev was observed in a radiochemically pure berkelium fraction. This curium isotope is probably Cm^{243} produced by the electron-capture decay of Bk^{243}. Chemical separations on the decay products of the Bk^{243} also revealed an americium isotope of ~ 15-hr half-life, which appears to be identical within the limits of error of the experiment with the known 12-hr electron-capturing Am^{239}. The cross section for the formation of Bk^{243} by the $(\alpha,2n)$ reaction is $\sim 10^{-28}$ cm². The chemical properties of the berkelium are typical of those of the actinide elements. Its tripositive oxidation state bears the same relationship to curium as does terbium to gadolinium as shown by the separations on ion exchange resin columns. The analogy between these two groups of elements is apparent, indicating the same kind of break in ionic radius at the point of half-filling of the 5f electron shell (curium) for the actinide elements as has been known to exist for the anal-

PHYSICS

ogous point of half-filling of the 4f electron shell (gadolinium) for the lanthanide elements. The oxidation potential for the (III) – (IV) couple of berkelium is close to that of the corresponding couple for cerium (~ −1.6 volts). (auth)

5445 The New Element Californium (Atomic Number 98). S. G. Thompson, K. Street, Jr., A. Ghiorso, and G. T. Seaborg. AECD-2885, June 19, 1950, Decl. Aug. 2, 1950. 25p.

Definite identification has been made of an isotope of the element with atomic number 98 through the irradiation of Cm^{242} with about 35-Mev helium ions in the Berkeley Crocker Laboratory 60-in. cyclotron. The isotope which has been identified has an observed half-life of about 45 min and is thought to have the mass number 244. The observed mode of decay of 98^{244} is through the emission of alpha particles, with energy of about 7.1 Mev, which agrees with predictions. Other considerations involving the systematics of radioactivity in this region indicate that it should also be unstable toward decay by electron capture. The chemical separation and identification of the new element was accomplished through the use of ion exchange adsorption methods employing the resin Dowex-50. The element 98 isotope appears in the eka-dysprosium position of elution curves containing berkelium and curium as reference points—that is, it precedes berkelium and curium off the column in like manner that dysprosium precedes terbium and gadolinium. The experiments so far have revealed only the tripositive oxidation state of eka-dysprosium character and suggest either that higher oxidation states are not stable in aqueous solutions or that the rates of oxidation are slow. The successful identification of so small an amount of an isotope of elements 98 was possible only through having made accurate predictions of the chemical and radioactive properties. 15 references. (auth)

5446 Adsorption Exchange of Radioactive Ions on Paper. E. Broda and T. Schönfeld. Monatsh. Chemie 81, 459-61(1950)(in German).

The adsorption on paper of ThB (Pb^{212}) was found to be strongly dependent on the pH of the particular solution, indicating an exchange equilibrium $Pb^{++} \rightleftharpoons H^+$. A study of the replacing ability of different ions showed large variations among them ($Pb^{++} > Cu^{++} > H^+ \gg Ba^{++} \gg K^+$). Similar results were obtained with radioactive Rb^{86}.

5447 Electromagnetic Enrichment of Fe^{58} Content and Concurrent Impoverishment of Fe^{54} Content in Iron. C. P. Keim, H. W. Savage, and Boyd Weaver. Science 112, 47(1950) July 14.

In the pile production of Fe^{59}, important in physiological studies, iron enriched in Fe^{58} must be used in order to minimize the concurrent production of Fe^{55}. The latter is favored by both the greater natural abundance and the larger neutron cross section of Fe^{54}. This is a short report on the best collection, to date, by the Y-12 Research Laboratory calutrons, the ratio Fe^{58}/Fe^{54} being increased to 287 from the natural value of 0.06.

5448 A Modification of the Theory of the Thermal Diffusion Column. H. G. Drickamer, E. W. Mellow, and L. H. Tung. J. Chem. Phys. 18, 945-9(1950) July.

PHYSICS

Thermal diffusion measurements were made for the system argon-neon over a pressure range from 4 to 108 atmospheres. It is found that the classical theory of Furry et al. (Phys. Rev. 55, 1083(1939)) is inadequate to describe the results obtained on a series of carefully constructed thermal diffusion columns. A modification of their theory, based on a more complete picture of the behavior of the column, is developed which fits the data satisfactorily. It is predicted and confirmed by experiment that even though turbulence occurs over part of the gap, a separation will occur, and may even be enhanced by this turbulence.

5449 Thermal Diffusion in the Critical Region. I. N. C. Pierce, R. B. Duffield, and H. G. Drickamer. J. Chem. Phys. 18, 950-2(1950) July.

Thermal diffusion data in the critical region have been obtained for the system ethane-xenon using very low xenon concentrations and Xe^{133} as a tracer. The results indicate that even at pressures as low as four atmospheres and temperatures twenty degrees above the critical, the simple kinetic theory of gases is not adequate to explain thermal diffusion. In the critical region evidence is found for the existence of clusters of ethane.

5450 Dispersion and Aberration in a Mass Spectrograph of the Magnetic Field Type. L. Musumeci. Nuovo cimento 7, 352-63(1950) May 31 (in Italian).

The problem of the focusing of charged particles is an object of particular studies in connection with its application in mass spectrometers of the magnetic field type. The cases of symmetric focusing, both perfect and approximated of the first and second order, are examined in the condition of utmost dispersion of the images. The rate of aberration is calculated in both cases. The need of a second order focusing is proved in order to reach a good separation of the isotopes of the heaviest elements when the initial divergence of the tracks is less than 10°. Other causes of aberration strictly connected with the operating of the mass spectrometer are particularly examined. (auth)

5451 The Centroid of a Convex Body. Preston C. Hammer. AECU-869, nd. 5p.

For any particular closed convex body, the minimum for all interior points of the maximum ratios into which chords are divided by interior points is called the critical ratio and denoted by r. Hence proof is established that $\frac{1}{4} \leq r \leq \frac{1}{3}$ for closed planar convex bodies, which generalizes immediately to $\frac{1}{4} \leq r \leq n/(n+1)$ for n-dimensional closed convex bodies.

5452 Matrix Treatment of Relative Orientation of the Multiplex Aero Projector. William A. Allen. AECU-870, nd. 8p.

The problem involves 2 projectors, one of which has 6 degrees of freedom, the other being fixed at the origin of coordinates. Relative orientation is defined as the sequential adjustments of the degrees of freedom of the movable projector such that $P \rightarrow O$ for all image points, P being the magnitude of the parallax (for a displacement of the projector in an arbitrary direction) at the image point. The solution to assure the above condition is effected by matrix methods.

5453 Fast Neutron Counter for Health Physics Measurements. J. S. Reddie and G. H. Whipple, Jr. HW-17561, Mar. 31, 1950. 17p.

PHYSICS

A simple and effective fast neutron counter suitable for health physics measurements has been constructed and field tested. A 5.25 cm diameter brass chamber 30 cm long filled with one atmosphere of methane together with commercially available electronic equipment results in an instrument whose counting rate is 2.5 cpm per fast neutron per sec per sq cm over an internal alpha background of 0.3 cpm. The unit is insensitive to gamma rays up to dosage rates of at least 20 r per hr. However, in the present models, a cadmium sleeve over the chambers is necessary to nullify the slight thermal neutron sensitivity. (auth)

5454 An Application of Geiger Counter Tubes for Spectrochemical Analysis. O. G. Koppius. Philips Tech. Rev. 11, 215-20(1950) Jan.

A spark discharge is maintained between two Cu electrodes in the air of a plant where atmospheric contamination with Pb or Pb compounds can occur through possible leaks in plant installations. If Pb is present the spark will contain the Pb line at 2203 A. By a small quartz spectrograph provided with a movable slit in its focal plane, this spectral line is isolated and its intensity is measured by a photoelectric Geiger counter tube with counting rate meter. The sensitivity of the apparatus in normal operation is limited to about 0.60 mg Pb per m^3 air by the fluctuations of the background intensity emitted by the spark. Although this is more than the maximum permissible concentration (0.15 mg per m^3), the instrument has proved very useful as a means for detecting and locating small leaks in pipes or valves, in whose vicinity high Pb concentrations may occur.

5455 Counting and Spectrometry with Proportional Tubes. S. C. Curran. Atomics (London) 1, 221-9(1950) Aug.

The typical constructional details and response characteristics of proportional counters are described. Brief notes are made of their use in the spectrometry of α, β, and γ rays, protons, and neutrons, the applications to β and γ radiation being divided under the headings of soft and hard radiation. The problem in the latter case is basically that of confining the fast primaries or secondaries within the operating volume and the use of magnetic fields for trapping them there is described. A number of advantages of the proportional tube over both the ionization chamber and G-M tube are discussed.

5456 Gamma-Ray Measurements with NaI(Tl) Crystals. R. Hofstadter and J. A. McIntyre. Phys. Rev. 79, 389-91(1950) July 15 (Letter to the editor).

The method of measuring γ-ray energies by observing pulse heights in NaI(Tl) crystals is extended to the energy range where "pair lines," or peaks due to pair production, are observed. These occur at 1.02 Mev below the photoelectric peak. The general method is thus to observe associated triads consisting of two sharp lines separated by a broad-peaked Compton distribution.

5457 Gamma-Rays from Po—Be Neutron Source and the Excited State of C^{12}. P. R. Bell and W. H. Jordan. Phys. Rev. 79, 392-3(1950) July 15 (Letter to the editor).

The γ ray from C^{12}, in the $Be^9(\alpha,n)C^{12}$ reaction, was measured as 4.44 ± 0.03 Mev with a NaI(Tl) crystal shielded by paraffin and boron. Three peaks at 4.42, 3.94, and 3.44 Mev were ascribed respectively to (1) complete absorption both through the photoelectric effect and by capture of the two

PHYSICS

members and the annihilation radiation in pair production, (2) capture of a pair with escape of one annihilation quantum, and (3) capture of a pair with escape of both quanta.

5458 Gap Measurement as a Method of Analysing Cosmic Ray Stars in Photographic Emulsions. P. E. Hodgson. Phil. Mag. 41, 725-8(1950) July (Correspondence).

Owing to the recent increase in sensitivity of photographic emulsions for nuclear research, tracks of particles of moderate energy are clogged, that is, the grains coalesce to form continuous blocks. While grain counting is usually more convenient, gap measurement must be used beyond 1.5 grains per micron. In order to relate the gap density to the energy loss, measurements of gap versus residual range were made on the tracks of a number of particles, of different mass and charge, ending in the emulsion of an Ilford G5 plate exposed on the Jungfraujoch. The energy losses at points along the tracks were calculated from the known range-energy curves (Bradner et al., Phys. Rev. 77, 462(1950)) and hence a graph of gap density versus energy loss was constructed. Empirical formulas are given for the relation between gap density and energy loss.

5459 Geiger Counters. M. Berger and L. Fontes. J. Radiol. Electrol. 31, 302-8(1950)(in French).

The authors discuss the discharge mechanism, properties, and uses of Geiger counters.

5460 High Temperature Ionization Chamber Mark I. D. H. Morley. General Engineering and Consulting Laboratory. Report R-50GL126, May 15, 1950. 12p.

A slow neutron detector capable of counting high neutron fluxes and operating at a temperature up to 250°C has been constructed. The counter is composed of 3 concentric cylinders, the adjacent surfaces of the 2 inner ones being coated with metallic boron containing about 20% of B^{10}. The chamber is filled to one atmospheric pressure with dry argon, 99.6% pure, and has an output current of $nv \times 10^{-15}$ amp, where nv is the neutron flux. The construction details are described.

5461 Nuclear Emulsions Studied with an Electron Microscope. G. Baroni and C. Castagnoli. Nuovo cimento 7, 364-71(1950) May 31 (in Italian).

The form and size of the AgBr grains and the development process in some photographic plates for nuclear research were observed with an 18,000 × electron microscope. (auth)

5462 Nuclear Induction and the Structure of Catalytically Active Solids. Robert B. Spooner. Summaries of Doctoral Dissertations, Northwestern Univ. 17, 399-401(1949) June-Sept.

This is a short summary of the use of nuclear induction in studying paramagnetic catalysts. Various concentrations of oxides of iron, manganese, and neodymium, supported on inert materials, influenced the relaxation time of proton spins in water, giving a direct measure of the surface dispersion of active atoms.

5463 On the Measurement of Scattering in a Photographic Plate. V. Goldschmidt-Clermont. Nuovo cimento 7, 331-50(1950) May 31.

PHYSICS

The methods are described which are employed at the Nuclear Physics Center of Brussel's Free University in order to obtain information on mass, charge and velocity of the very energetic particles, through the measurement of their multiple scattering. The paper discusses also particularly the eventual causes of error which limit the precision of the reported methods. (auth)

5464 On the Shift of the Nuclear Magnetic Resonance in Paramagnetic Solutions. N. Bloembergen. Phys. Rev. 79, 178-80(1950) July 1 (Letter to the editor).

In the measurement of gyromagnetic ratios of nuclear spins, paramagnetic ions are often added to the liquid sample in order to reduce the relaxation time. The resonance frequency depends, however, on this addition because of the contribution to the local field at the nucleus from the paramagnetic ions inside a small sphere around the nucleus. The purpose of this letter is to present a possible explanation of the interaction factor q which, multiplied by the magnetic moment, must be added as a correction term to the applied magnetic field.

5465 Scintillation Counting. G. Cowper. National Research Council of Canada Report LE-22, June 1949. 21p.

This article is derived from a lecture given at Chalk River. The topics discussed are: (1) early history of scintillation counting; (2) operating characteristics of photomultiplier tubes; (3) the structure and required features of phosphors for scintillation counting; (4) some of the uses to which scintillation counters have been put. 47 references.

5466 A Stable Ninety-Nine Channel Pulse Amplitude Analyzer for Slow Counting. D. H. Wilkinson. Proc. Cambridge Phil. Soc. 46, 508-18(1950) July.

The instrument described in this paper was designed as a ninety-nine-channel kick sorter of high stability and simple construction. It is linear in its calibration and will accept a fairly wide variety of input pulses. The instrument has no pretensions at all as to speed, this being limited by the fact that each channel records directly on a telephone-message register which has a dead time of about a tenth of a second. Thus the maximum rate of digestion of pulses is about ten per second. The machine incorporates, however, a blocking circuit which renders it insensitive for a tenth of a second after the acceptance of any pulse, and so the input rate may be quite high, the kick sorter dealing with the pulses at its own speed. The stability is determined essentially by a resistance-capacity time constant and the 300-volt line, and is found to be considerably better than 1% over a period of months without any attention to the machine.

5467 A Toroid γ Counter with High Solid Angle for Coincidence Spectrometry. Kai Siegbahn and Hilding Slätis. Arkiv Fysik 2, No. 1, 5-8(1950).

A toroid counter is shown and described as subtending, with a sample at the center, a solid angle of about 50% of the sphere. The anode wire is a loop suspended on pyrex rods.

5468 Removal of Radioactive Particles from Gases by the Trion Electrostatic Precipitator. T. F. Furlong, H. C. Harrison, J. F. O'Donnell, and R. P. Webb. K-615, June 23, 1950. 27p.

PHYSICS

Operational tests were made on a Trion electrostatic precipitator to determine its effectiveness in removing radioactive dust from cell vent gases and its activity buildup characteristics. A Trion unit has a decontamination efficiency of 93% when operating at 840 cfm of cell vent gases, and the efficiency decreases only 3% with a 55% increase of gas flow rate. The effects of flow rate variation on decontamination efficiency and pressure drop, and the activity of the unit during buildup and washdown were determined. Results show that the pressure drop across a Trion unit is less than one inch of water at gas flow rates up to 1560 cfm. (auth)

5469 Excited Electronic Levels in Conjugated Molecules. IV: Symmetrical Cyanine Dyes. W. E. Moffitt. Proc. Phys. Soc. (London) 63A, 700-7(1950) July 1.

Topics in the electronic theory of the color of symmetrical cyanine dyes are discussed by means of resonance formalism. The conclusions for the formamidinium ion are confirmed by use of the molecular orbital method. As a result of this analysis, certain modifications in the qualitative symbolism of color theory are put forward in the hope of developing a more reliable picture of the absorption process.

5470 The Microwave Rotational Spectrum and Structure of Bromogermane. A. Harry Sharbaugh, Benjamin S. Pritchard, Virginia G. Thomas, John M. Mays, and Benjamin P. Dailey. Phys. Rev. 79, 189(1950) July 1 (Letter to the editor).

The authors have measured and identified about 100 lines arising from the 4th, 5th, and 6th pure rotational transitions of Ge^{70}, Ge^{72}, Ge^{74}, and Ge^{76} in the 8 possible combinations with Br^{79} and Br^{81} in GeH_3Br. The measured frequencies (J = 4-5) are tabulated for the 8 cases along with computed B_0 values. A dipole moment of 1.31 ± 0.03 Debye units was found for SiH_3Br from movement of Stark components. Structural data and quadrupole coupling constants for GeH_3Br are compared with those for CH_3Br and SiH_3Br.

5471 Nuclear Magnetic Resonance in Metallic Hydrides. Martin A. Garstens. Phys. Rev. 79, 397-8(1950) July 15 (Letter to the editor).

To determine the disposition of hydrogen in titanium hydride, the resonance absorption line width was measured. A width of 12 gauss, independent of the hydrogen concentration (38, 72, and 157 H atoms per 100 Ti atoms), indicated that the H atoms were sufficiently close, probably in molecular form, to allow strong interaction and that they were in relatively fixed positrons. In contrast, the line width for tantalum hydride was less than 1 gauss, indicating rapid internal motion.

5472 The Radiofrequency Spectrum of $Rb^{85}F$ and $Rb^{87}F$ by the Electric Resonance Method. Vernon Hughes and Ludwig Grabner. Phys. Rev. 79, 314-22(1950) July 15.

The r-f spectrum of the two molecular species $Rb^{85}F$ and $Rb^{87}F$ was studied by the molecular beam electric resonance method. The electrical quadrupole interaction constant, eq_1Q_1/h, of Rb in RbF was determined for $Rb^{87}F$ in rotational states J = 1 and J = 2 for the first few vibrational states, and for $Rb^{85}F$ in rotational state J = 1 for the first few vibrational states. The interaction constants are unusually large for an

PHYSICS

alkali halide molecule; for the zeroth vibrational state of $Rb^{85}F$, $eq_1Q_1/h = -70.31 \pm 0.10$ Mc/sec and for the zeroth vibrational state of $Rb^{87}F$, $eq_1Q_1/h = -34.00 \pm 0.06$ Mc/sec. The absolute value of the interaction constant decreases about 1.1% from one vibrational state to the next higher one; the values of the interaction constants for rotational states J = 1 and J = 2 are the same within the limit of error. The ratio of the electric quadrupole moment of Rb^{85} to that of Rb^{87} is $+2.07 \pm 0.01$. Results are reported on the spin-orbit coupling $c_2(\mathbf{I}_2 \cdot \mathbf{J})$, between the spin of the fluorine nucleus and the molecular rotational angular momentum. For the zeroth vibrational state of $Rb^{85}F$, $|c_2/h| = 11 \pm 3$ kc/sec and for the zeroth vibrational state of $Rb^{87}F$, $|c_2/h| = 14 \pm 4$ kc/sec. No variation in $|c_2/h|$ with vibrational state was observed. Finally, an unpredicted line group was observed in the spectrum at one-half the frequency of one of the line groups in the $Rb^{85}F$ spectrum. Possible origins of this line group are discussed, including that of a double quantum transition. The vibrational frequency, ω_0, of $Rb^{85}F$ is 340 ± 68 cm^{-1}.

5473 On the Theory of Slow Neutron Scattering by Solid and Liquid Helium. L. Goldstein and D. W. Sweeney. AECU-868, nd. 13p.

The slow neutron scattering properties of solid and liquid helium are studied in this paper, on the assumption that both of these condensed phases have a similar crystal structure. It is shown that, according to this limiting solid model, liquid helium, in contrast with usual structures, should exhibit a smoothly increasing total scattering cross section from the lowest group of neutron energies available at present up to those higher energies at which the asymptotic, free atom cross-section value should be approached. (auth)

5474 Collisions of High-Energy Nuclear Particles with Nuclei. B. J. Moyer and G. F. Chew. UCRL-663, Apr. 26, 1950. 30p.

The authors present a general review of the effects observed in the collisions of nuclei with very energetic nuclear particles. Some of the topics discussed are the production of high energy neutrons, collision cross sections and nuclear transparency, the elastic scattering of neutrons at 84 Mev, and nuclear disintegration types at high energies (spallation and stars, high energy fission, and sub-nuclear collisions). 25 references.

5475 The D-D Reaction as a Standard Neutron Source. K. G. McNeill, P. C. Thonemann, and F. V. Price. Nature 166, 28(1950) July 1 (Letter to the editor).

The ${}_1D^2 + {}_1D^2$ reaction yields ${}_2He^3 + n$ and ${}_1H^3 + {}_1H^1$. It is difficult to determine the absolute neutron intensity by counting the ${}_2He^3$ particles because of the short range of the latter. To eliminate this difficulty, the authors measured the ratio ${}_2He^3$: ${}_1H^3$: ${}_1H^1$ using a proportional counter and then, stopping the ${}_2He^3$ and ${}_1H^3$ particles with an aluminum window, counted the absolute number of protons. From this information the absolute number of neutrons could be calculated. This was done at the incident beam energies from 70 to 160 kev.

5476 Determination of the Diffusion Length and Second Spatial Moment of Thermal Neutrons in Water with a Small Boron Chamber. Karl-Erik Larsson. Arkiv Fysik 2, No. 1, 47-59(1950).

PHYSICS

The diffusion length of thermal neutrons in water was obtained by immersing a Ra-Be source and a small BF_3 counter in a tank at measured distances apart. The difference in spatial distribution of the thermal neutrons when a spherical cadmium shell filled with $CdSO_4$ solution surrounded the source allowed calculation of the diffusion length as L = 3.25 ± 0.13 cm. Although age-diffusion theory was admitted to be a poor approximation in the case of slowing down in water, the second spatial moment $\langle r^2 \rangle$ was determined from $\langle r^2 \rangle = \int_0^\infty Ir^4 dr / \int_0^\infty Ir^3 dr$ where I was the number of counts per minute at a distance r. This gave 366 cm^2, thought to be more accurate than reported results with Dy- and In-detectors.

5477 Neutron Angular Distributions and Spectra Produced by the Bombardment of Thick Targets by Deuterons. C. E. Falk. Carnegie Institute of Technology, July 1, 1950. 143p. (AEC File No. NP-1622.)

Thick targets were bombarded with 15-Mev deuterons and the resulting neutron angular distributions and spectra were observed. Threshold detectors and a proportional counter telescope, consisting of 4 proportional counters, were used to make these measurements. It was observed that the angular distributions of the neutrons is sharply peaked in the forward direction, showing single peaks for some target elements and "double" peaks for others. The neutron spectra could generally be fitted on a curve:

$$I_n(E_n) \sim \frac{1}{E_n} e^{-E_n/a}$$

where a is a constant which is characteristic of the target element. However, it was found that when the spectra coming from the same target are measured at different angles, the spectrum at 90 deg showed a relative increase in low energy neutrons. These results are compared with the data predicted by present day theories of neutron production from deuteron bombardment. It is found that stripping gives a fair qualitative agreement for the spectra and angular distributions, but that the relative neutron yield from various targets are in disagreement with the yields predicted by stripping. It is pointed out that electric disintegration of the deuteron in flight can possibly account for the observed angular distributions. (auth)

5478 Progress Report. October 1, 1948, to September 30, 1949. Rice Institute, Sept. 30, 1949. 44p. (AEC File No. NP-1387.)

This progress report consists of the following four articles: (1) Voltage stabilization for electrostatic generators using an electron gun, by S. J. Bame, Jr., and L. M. Baggett; (2) Disintegration of Li^6 by deuterons, by Ward Whaling; (3) Pair spectrometer investigation of polonium-beryllium gamma rays, by James Terrell; (4) Long-range protons from the disintegration of carbon by deuterons and a comparison of competing reactions, by G. C. Phillips.

5479 Seventh Semi-Annual Report. W. F. G. Swann. Bartol Research Foundation, Mar. 15, 1950. 125p. (AEC File No. NP-1624.)

Research activities and results concerning the following are reported: magnetic deviation of cosmic-ray particles in the atmosphere; cosmic-ray investigations at very high alti-

PHYSICS

tudes; theory of angular correlation phenomena; neutrons from the disintegration of Mg^{25} and Mg^{26} by deuterons; instrumentation and nuclear reactions relating to the Van de Graaff generator; radioactivity of Ce^{144}, Pr^{144} and Ce^{143}; the reactions $Li^7(d,n)Be^8$; $B^{10}(d,\alpha)Be^8$, and $B^{11}(d,\alpha)Be^9$; slow discharge in a nonself-quenching G-M counter; charge-time curves; assembly of equipotential rings on the Van de Graaff generator; and construction of a linear accelerator.

5480 Angular Correlation in the Reaction $F^{19}(p,\alpha)O^{16*}(\gamma)O^{16}$. W. R. Arnold. Phys. Rev. 79, 170(1950) July 1. (Letter to the editor).

Spins and parities in the reaction $F^{19}(p,\alpha)O^{16*}(\gamma)O^{16}$ were investigated with the aid of α-γ coincidence measurements. The angular distribution, at the 330-kev resonance, was found to fit only the case of spins 1,3, and 0 for the compound nucleus Ne^{20*}, for O^{16*}, and for O^{16} ground state, respectively, and an angular momentum of 3 for the α particle. This is taken to mean that if the parity of F^{19} is even, Ne^{20*} has even parity and O^{16*} odd parity. Even parity for both Ne^{20*} and the ground state of O^{16} with a spin difference of 1 would account for the absence of long range α's at this resonance.

5481 Consistency of Nuclear Radii of Even-Even Nuclei from Alpha-Decay Theory. I. Perlman and T. J. Ypsilantis. Phys. Rev. 79, 30-4(1950) July 1.

It is shown possible to obtain a consistent function for nuclear radii if the quantitative treatment of the α-decay process is applied to even-even isotopes of the heavy elements. The nuclear radii so calculated for even-even isotopes of emanation, radium, thorium, uranium, plutonium, and curium, conform to the expression $r = 1.48\ A^{1/3} \times 10^{-13}$ cm which defines the normal nuclear radii. The agreement is within 1% for the majority of the cases and there is reason to question the experimental data used in the calculations for at least part of those which do not show such close agreement. In cases of fine structure in α decay of even-even nuclei, the radii calculated from the separate α groups are compatible. The polonium isotopes and Em^{212} (Rn^{212}) form a special group showing departures from normal nuclear radii explainable by consideration of shells in nuclear structure. (auth)

5482 Fundamental Lengths and Masses of Fundamental Particles. H. T. Flint. Nature 166, 30(1950) July 1 (Letter to the editor).

In the case of the proton, of rest mass M_0, the length h/M_0c might be regarded as the fundamental length of the order of 10^{-13} cm, which has come to be described as the range of nuclear forces. The range of nuclear forces might also be identified with the expression ke^2/m_0c^2, where m_0 is the rest mass of the electron. Unlike the other expressions, this contains a numerical constant k which is not well defined theoretically. Setting $h/M_0c = ke^2/m_0c^2$ and knowing the value of the fine structure constant and M_0/m_0, k comes out as 0.4688. This value is in excellent agreement with Furth's value (Physik. Z. 30, 895(1929)) of 0.46875 obtained by other considerations.

5483 Gamma-Rays from the Reaction $H^1(n,\gamma)D^2$ and the Binding Energy of the Deuteron. R. E. Bell and L. G. Elliott. Phys. Rev. 79, 282-5(1950) July 15. (See also NSA 2-175.)

The binding energy of the deuteron has been determined directly as 2.230 ± 0.007 Mev by measuring the energy of the γ radiation from the reaction $H^1(n,\gamma)D^2$. The energy of this γ radiation was compared with that of the 2.615-Mev γ ray of ThC″ by a spectrometer study of the photoelectrons ejected from a thin uranium radiator. The probable error of 0.007 Mev includes a probable error of 0.004 Mev in the energy of the ThC″ γ ray. (auth)

5484 The Hyperfine Structure of Ni^{61}. Karl G. Kessler. Phys. Rev. 79, 167(1950) July 1 (Letter to the editor).

Interference spectrograms of nickel (80% Ni^{61}), at liquid nitrogen temperature, showed no clear hyperfine structure splitting but lines involving the $d^9s^3D_3$ level showed broadening in excess of the Doppler effect. The upper limit of the magnetic moment appeared to be of the order of 0.25 nuclear magneton.

5485 Masses of Si^{30}, Co^{59}, Ni^{60}, Zr^{90}, Mo^{96} and Mo^{100}. Henry E. Duckworth, Richard S. Preston, and Karl S. Woodcock. Phys. Rev. 79, 188-9(1950) July 1 (Letter to the editor).

A number of mass comparisons, made with a spark source mass spectrometer, led to determinations of packing fraction differences of the doublets CH_3-Si^{30}, Si^{30}-Ni^{60}, Si^{30}-Zr^{90}, C_2-Mo^{96}, and C_2H-Mo^{100}. Combining these with accepted values for CH_3, C_2, and C_2H led to the packing fractions and mass determinations below. Values for Co^{59} were deduced from those of Ni^{60}, using disintegration data.

Nuclide	Packing Fraction	Mass
Si^{30}	−5.70 ± 0.05	29.98290 ± 0.00015
Co^{59}	−8.43	58.95029
Ni^{60}	−8.60 ± 0.05	59.94840 ± 0.00030
Zr^{90}	−7.58 ± 0.07	89.93178 ± 0.00063
Mo^{96}	−6.67 ± 0.04	95.93597 ± 0.00039
Mo^{100}	−6.14 ± 0.04	99.93860 ± 0.00040

5486 Masses of Si^{28}, Si^{29}, Mn^{55}, Fe^{56}, Ni^{58}, Pd^{110}, Cd^{110}, Cd^{112}, Cd^{116}, and Sn^{116}. Henry E. Duckworth and Richard S. Preston. Phys. Rev. 79, 402(1950) July 15 (Letter to the editor).

Packing fraction differences, found with a spark-source mass spectrograph, are combined with known values to derive the packing fractions, and from them the masses, of the nuclides named in the title. The mass of Mn^{55} is deduced from that of Fe^{56} by using disintegration data.

5487 Neutron Capture Gamma-Ray Multiplicity. C. O. Muehlhause. Phys. Rev. 79, 277-9(1950) July 15.

The average number of γ rays per neutron, in cascade after neutron capture, was measured for about 30 isotopes. The number increased, on the average, with atomic weight. In the light element region it was ~2.5 for odd-even and even-odd and ~1.7 for even-even nuclei.

5488 Nuclear Induction. Felix Bloch. Phys. Today 3, No. 8, 22-5(1950) Aug.

A brief review is given of the basic principles of nuclear induction and their application in the determination of nuclear magnetic moments. The influence of chemical binding upon resonance width and frequency is discussed.

PHYSICS

5489 On the Energy of the Alpha-Particles from Radioactive Nuclei. M. H. L. Pryce. Proc. Phys. Soc. (London) 63A, 692-700(1950) July 1.

When the energy of α particles emitted by radioactive nuclei is compared with the energy calculated from the usual semi-empirical formula for nuclear binding energies, systematic variations ranging from 4.5 Mev to −1.0 Mev are found, which exhibit in a very clear way the special importance of configurations containing 82 protons and/or 126 neutrons. The general features are readily explained in terms of the shell model. The analysis can be used to predict unknown α energies. Calculated α energies are tabulated for the heavy nuclei ($Z \geq 78$) and for nuclei in the rare-earth region.

5490 The Question of Isomerism in Ca^{49}. E. der Mateosian and M. Goldhaber. Phys. Rev. 79, 192-3(1950) July 1 (Letter to the editor).

The reported isomerism in Ca^{49} would be contrary to the spin-orbit coupling model of nuclear shell structure since the onset of isomerism should not take place below 39 odd nucleons. Ca^{49}, with its 29 odd neutrons in an odd-even nucleus, was carefully investigated and found to have but one half-life, 8.5 min, in agreement with theory. Decay is to Sc^{49} by emission of β rays with an energy, found by absorption of ~2.7 Mev. The only other such case of isomerism reported is that of Ti^{51}, with periods of 6 min and 72 days. This also was carefully investigated and the shorter period was not found.

5491 The Uniform Theory of Nuclear Binding Energies. Technical Report No. 43. David H. Frisch. MIT Laboratory for Nuclear Science and Engineering, June 23, 1950. 48p. (AEC File No. NP-1615.)

The present paper is a review of Wigner's "uniform" theory of nuclear binding energies, with the following additions: (1) The potential energy is generalized by using other exchange operators as well as the Majorana operator. (2) A rough calculation of the magnitude of the interaction integrals is made from the forces between the elementary nucleons, leading to a calculation of the potential energy and a discussion of stability at the observed nuclear radii. The results are that (1) the uniform model cannot be improved appreciably by a reasonably more general potential operator; (2) the calculated interaction integrals cannot give the observed binding energies and radii simultaneously. (auth)

5492 The Mode of Operation of the Uranium Reactor. Ragnar Liljeblad. Arkiv Fysik 2, No. 1, 17-25 (1950)

This is a revision and addition to the author's former article (Arkiv Mat. Astron. Fysik 36B, No. 1 (1948)), abstracted in Nuclear Science Abstracts as Abstract 4-261, in which he calculated the probable relative energy outputs of different designs for a pile. Considering now the thermal absorption by U^{238}, but still disregarding the absorbing effects of fission products, he arrives again at his former conclusions.

5493 Total Cross Sections of Nuclei for 42-Mev Neutrons Roger H. Hildebrand and Cecil E. Leith. AECD-2875, May 9, 1950, Decl. July 11, 1950. 21p.

Total cross sections of 33 elements for 42-Mev neutrons have been measured using the 184-inch cyclotron as a source of neutrons and the $C^{12}(n,2n)C^{11}$ reaction as a detector. Experimental details are described and the results are compared with those measured at other energies. (auth)

5494 The Angular Distribution of High Energy Neutrons from Targets Bombarded by 330-Mev Protons. R. D. Miller, D. C. Sewell, and R. W. Wright. AECD-2884, June 22, 1950, Decl. Aug. 2, 1950. 17p.

The angular distribution of neutrons with energies above 20 Mev produced by bombardment with the 350-Mev proton beam in the 184-inch cyclotron of Be, Al, Cu, and U targets has been measured with carbon detectors. The full widths at half maximum obtained are 54° for Be, 59° for Al and Cu, and 58° for U. Experimental details and the resulting curves are given. 11 references. (auth)

5495 Carrier-Free Radioisotopes from Cyclotron Targets. X. Preparation and Isolation of Mg^{27} from Aluminum. Herman R. Haymond, John Z. Bowers, Warren M. Garrison, and Joseph G. Hamilton. UCRL-698, May 8, 1950. 4p.

The 10.2 min Mg^{27} was produced from aluminum by the nuclear reaction $Al^{27}(d,2p)Mg^{27}$ using the 20-Mev deuteron beam of the 60-in. cyclotron at the Crocker Laboratory. With deuterons of this energy, 14.8 hr Na^{24} is also produced in comparable yield by the reaction, $Al^{27}(d,\alpha p)Na^{24}$. Other possible concurrent reactions produce radioisotopes having half-lives of only a few sec, with the exception of the 2.3-min Al^{28}. The separation described here is based on the observation that carrier-free Mg^{27} in alkaline solution forms radiocolloidal aggregates which may be removed by filtration. Corrected for decay, a yield of 2.5 mc per μa hr was obtained.

5496 Angular Distributions of Ground-State Protons from B^{10} + D. W. C. Redman. Phys. Rev. 79, 6-11(1950) July 1.

The angular distributions of the ground-state protons resulting from the deuteron bombardment of B^{10} were investigated at six energies in the 1- to 4-Mev interval. The reaction protons were recorded photographically at all angles from 5° to 165° and their distribution was determined by microscopic examination of the photographic emulsion. The resulting intensity variation with angle can be expressed within experimental error as a second-order Legendre polynomial series for all energies except the highest, for which a fourth-order series is required. S-wave deuterons predominate in producing this reaction, but p-wave effects occur even for the lowest energy distribution studied. D-wave contributions are noticed for deuteron energies above 3 Mev. The behavior of the coefficients in the series representation shows that several broad overlapping resonance levels, of both even and odd parity, in the compound nucleus probably enter into this reaction. (auth)

5497 The Angular Distribution of Protons from the $B(\alpha,p)C,C^*$ Reaction. J. L. Perkin. Phys. Rev. 79, 175-6(1950) July 1 (Letter to the editor).

In this study of the $B(\alpha,p)C,C^*$ reaction, boron was bombarded with polonium α particles, the emitted protons being recorded in Ilford plates. Nonresonance and resonance experiments were performed. In the former, the α-particle energy of 4.3 Mev corresponded to the top of the B^{10} potential barrier. The proton tracks (about 4000) were in groups corresponding to Q-values of 4.08 ± 0.12, 3.35 ± 0.25, 0.65 ± 0.15,

PHYSICS

0.15 ± 0.15, and −0.57 ± 0.15 Mev. All the angular distributions showed some degree of anisotropy and asymmetry, particularly in the case of the ground state group at 4.08 Mev. In the resonance experiment one group was found; assuming this to be the ground state group gave 2.9 Mev for the α-particle resonance energy. The distribution at resonance was practically isotropic between 30° and 150°.

5498 Disintegration of Li^6 by Deuterons. Ward Whaling and T. W. Bonner. Phys. Rev. 79, 258-61(1950) July 15.

The cross sections of the $Li^6(d,\alpha)\alpha$ and $Li^6(d,p)Li^7,Li^{7*}$ reactions have been measured up to energies of 1600 kev. Evidence of a resonance level in Be^8 for 347 kev deuterons is presented. The angular distribution of the two proton groups has been observed at 400, 600, 1000, and 1400 kev. The complexity of the angular distribution increases with bombarding energy, requiring a P_3 term in the Legendre polynomial expansion at the highest bombarding energy. (auth)

5499 Disintegration of Neon by Fast Neutrons. C. P. Sikkema. Nature 165, 1016-17(1950) June 24 (Letter to the editor).

Neutrons from the D + D reaction were detected with a neon-filled counter. For different neutron energies, pulses were registered and pulse-size distribution was determined. One group was observed at most neutron energies between 2.2 and 3.4 Mev, the pulse size always indicating an energy 0.6 to 0.7 Mev less than these. This group, the only noticeable one, is ascribed to the $Ne^{20}(n,\alpha)O^{17}$ reaction with O^{17} left in the ground state. A plot of yield versus neutron energy showed peaks indicating excited levels of the intermediate Ne^{21} nucleus at 9.86, 10.33, and probable 10.75 Mev.

5500 The Ejection of Li^8 Nuclei by Gamma Rays. C. H. Millar and A. G. W. Cameron. Phys. Rev. 79, 182-3 (1950) July 1 (Letter to the editor).

"Hammer" tracks in an Ilford E1 emulsion, exposed to γ rays from a betatron operating at 26.7 Mev, are attributed to photo-emission of Li^8 nuclei from one of the heavy elements. These supposedly decay to Be^8 which immediately breaks into two α particles. Certain considerations favor Ag as the source of the Li^8.

5501 Gamma-Ray Spectra from B^{10}, B^{11}, and Be^9 under Proton Bombardment. R. L. Walker. Phys. Rev. 79, 172-3(1950) July 1 (Letter to the editor).

The spectra of γ rays emitted by B^{10}, B^{11}, and Be^9 when bombarded by protons have been measured with a γ-ray pair spectrometer. A single line at 9.47 ± 0.12 Mev, previously unobserved, was found in the case of separated B^{10}. The previously known lines at 4.41, 12.12, and 16.70 Mev were found in natural B (81% B^{10}), some indication being obtained that the relative intensity of the latter two lines depends upon bombarding proton energy. Be^9 bombarded with 1.2-Mev protons gave γ lines at 7.37 ± 0.07 and 6.82 ± 0.10 Mev.

5502 The Low Energy Neutron Spectrum from $Li^7(d,n)Be^8$. W. D. Whitehead. Phys. Rev. 79, 393-4(1950) July 15 (Letter to the editor).

Li_2SO_4, 99.8% Li^7, was bombarded with 1.1-Mev deuterons, the resulting neutrons producing recoil protons in Ilford C_2 plates. Besides the continuum of neutrons ascribed to

PHYSICS

$Li^7 + d \rightarrow He^4 + He^5$, $He^5 \rightarrow He^4 + n$, groups were found at 1.36 and 4.9 Mev. These are assigned to $Li^7 + d \rightarrow Be^8 + n$, indicating Be^8 levels at 14.7 and 11.1 Mev.

5503 Negative Energy Neutron Resonance in Cl^{35}. C. T. Hibdon and C. O. Muehlhause. Phys. Rev. 79, 44-5 (1950) July 1.

The neutron scattering cross section of chlorine has been measured at various energies in the range from 0 to 3 kev. These data have been fitted to a one-level Breit-Wigner scattering formula. A single real level (i.e., one of negative energy with respect to binding) in Cl^{36} at −75 ev is sufficient to account for the observed slow neutron properties of chlorine. (auth)

5504 Neutron-Induced Radioactivity in Palladium. A. Storruste. Phys. Rev. 79, 193(1950) July 1 (Letter to the editor).

The neutron-induced radioactivity in palladium has been investigated with a scintillation counter. Palladium of purity 99.995% was irradiated in the Harwell pile. The β and γ half-lives were found to be equal, both being in agreement with the 7.5 days previously reported for Ag^{111}. The γ rays gave an energy of 0.33 Mev and were found to be in coincidence with the β rays. The density of the γ rays was found to be 6.5 per 100 β particles. No γ-γ coincidences were recorded.

5505 Note on High Energy Induced Fission of Bi. Y. Yamaguchi. Progress Theoret. Phys. 5, 143-4 (1950) Jan.-Feb. (Letter to the editor).

It has been previously assumed by Goeckermann and Perlman (Phys. Rev. 76, 628(1949)) that the fission of bismuth by 190-Mev deuterons involved the reaction $Bi^{209}(d, 12n)Po^{199}$, the residual nucleus Po^{199*} then undergoing fission. The author justifies this assumption here, using the Bohr-Wheeler evaporation theory.

5506 Notes on High Energy Nuclear Evaporation. Y. Yamaguchi. Progress Theoret. Phys. 5, 142-3 (1950) Jan.-Feb. (Letter to the editor).

The problem of high energy nuclear evaporation is extended to include the evaporation of α particles as well as neutrons and protons. The results of several calculations are given in the form of curves showing relative n and p emissions at A = 100 with X = 100 and 200 Mev, and at A = 200 with X = 200 Mev. (A is the mass number and X is the excitation energy).

5507 Note on a Possible Annihilation Process for Negative Protons. J. Ashkin, T. Auerbach, and R. Marshak. Phys. Rev. 79, 266-71(1950) July 15.

Expressions are obtained for the annihilation cross sections of proton pairs using weak coupling theory and spin zero mesons. The cross section for annihilation into two charged mesons has a 1/v behavior in the limit of very small velocity, v, of the negative proton and dominates over the annihilation into two photons. In the laboratory coordinate system it is possible for one of the emitted mesons to emerge in the backward direction with respect to the direction of the incident negative proton even for large incident energies. This may provide a method for distinguishing high energy annihilation events taking place in the cosmic radiation. (auth)

PHYSICS

5508 Nuclear Power Engineering. Andrew W. Kramer. Atomics 6, No. 4, 11-19(1950) July-Aug.

The Gamow liquid drop theory of the nucleus is described in nontechnical terms, showing the role played by nuclear "temperature" and "surface tension" in the evaporation of nucleons and in fission.

5509 On the Identification of the Predominant Photo-Nuclear Disintegrations in Nitrogen and Oxygen. E. R. Gaerttner and M. L. Yeater. Phys. Rev. 79, 401(1950) July 15 (Letter to the editor)

Cloud-chamber observation of betatron x-ray-induced disintegrations in nitrogen and in oxygen showed a preponderance of those in which one charged particle was emitted. The direction of the resultant momenta indicated that a neutron, also, was emitted in about 66% of these cases in nitrogen and in about 16% in oxygen. The reaction $N^{14}(\gamma,np)C^{12}$ is suggested, various reasons being given for ruling out other neutron-yielding reactions.

5510 Photo-Alpha Reactions in Light Nuclei. T. A. Welton. Phys. Rev. 79, 399(1950) July 15 (Letter to the editor).

With the assumption that the O^{16} nucleus is composed of four pre-formed α particles, each strongly bound but interacting relatively weakly with its neighbors, and that a γ ray above 7.2 Mev can excite this structure to a state in its continuum in which one α emerges, a formula for the differential cross section is derived. An unusual dependence on angle ($\sin^2\theta\cos^2\theta$) results from pure electric quadrupole transition.

5511 Photo-Disintegration of Deuterium by 4.5 to 20.3 Mev X-rays. E. G. Fuller. Phys. Rev. 79, 303-9 (1950) July 15. (See also NSA 3-1421.)

A study is made of the angular distributions and the distribution in energy of the photoprotons arising from the photodisintegration of deuterium by the continuous x-ray spectrum produced when electrons accelerated in the betatron to a kinetic energy of 20.3 Mev impinged on a 0.005 in. Pt target. The collimated x-ray beam passed through a deuterium gas-filled reaction chamber in which nuclear emulsions were placed to detect the resulting photoprotons. The angular distributions for six photon energy intervals are consistent with a differential cross section $\sigma(\theta)$ in the center of mass system of the form: $\sigma(\theta) \approx a + \sin^2\theta\,(1 + \alpha\cos\theta)$ where α is a constant depending on incident energy and neutron-proton interaction. Assuming an intensity spectrum for the betatron radiation of the shape determined by Koch and Carter (Phys. Rev. 77, 165(1950)), a curve for the relative cross section for the photodisintegration of deuterium as a function of photon energy was determined. This curve falls off more slowly than does the Bethe-Peierls expression. The discrepancy, however, is within the experimental errors and the uncertainties in the spectrum of the betatron radiation. (auth)

5512 A Possible Nuclear Excitation Effect in Light, Fast Nuclei by Electromagnetic Influence. Bernard D'Espagnat. Compt. rend. 231, 38-40(1950) July 3 (in French). (See also NSA 4-3989.)

This is an extension of a previous article by the author on the same subject (Compt. rend. 230, 1268(1950)), taking into account new experimental laws on the absorption of γ rays. It is considered that the electromagnetic field which surrounds light nuclei in motion (as in cosmic rays) interacts directly with other nuclei. For the purposes of calculation, the method of Weisszacker and Williams is used in which the field is decomposed into a cloud of virtual photons. Weisskopf's semiempirical law is used in which the cross section for the absorption of photons by nuclei is roughly proportional to the cube of the energy of the photons. The author concludes that nuclear excitation by purely electromagnetic processes seems possible in the case of light, fast nuclei interacting with light nuclei.

5513 Proton Groups from the $B^{11}(d,p)B^{12}$ Reaction. W. W. Buechner, D. M. Van Patter, E. N. Strait, and A. Sperduto. Phys. Rev. 79, 262-5(1950) July 15.

Two proton groups observed when boron targets are bombarded with 1.5-Mev deuterons have been identified as arising from the $B^{11}(d,p)B^{12}$ reaction. The Q-values for these groups are 1.136 ± 0.005 and 0.189 ± 0.004 Mev, showing the presence of an excited state of B^{12} at 0.947 ± 0.005 Mev. The reaction energy for the ground-state group is in good agreement with that calculated from the masses and from the B^{12} β rays and indicates that the primary mode of decay of B^{12} to C^{12} is between the ground states of these nuclei. (auth)

5514 Successive Neutron Capture in Gold. R. D. Hill and J. W. Mihelich. Phys. Rev. 79, 275-7(1950) July 15.

Transitions corresponding to 159 and 209 kev have been observed in neutron-activated gold. They have been observed to decay with a half-life of 3.3 days and have been ascribed to Au^{199}, which is formed by a process of successive neutron capture from Au^{197}. The thermal neutron capture cross section of Au^{198} has been estimated to be of the order of 10^4 barns. (auth)

5515 Theory of the Photodisintegration and Formation of H^3 and He^3. M. Verde. Nuovo cimento 7, 283-306 (1950) May 31 (in Italian).

A similar article by the same author was published in Helv. Phys. Acta 23, No. 4, 453-74(1950). The article appeared in Nuclear Science Abstracts as Abstract 4-5306.

5516 On the Electron Dynamics in a One-Stage Linear Accelerator with Periodically Varying Field. Hans Lottrup Knudsen. Trans. Danish Acad. Tech. Sci. 1949, No. 3, 54p.

The electron dynamics in a one-stage linear accelerator with periodically varying field is investigated. Calculations are carried out for two extreme cases, very large and very small accelerating voltage, to determine electron motions, arrival times, efficiency, etc.

5517 Seventy-Million Volt Electron Beam Produced by Synchrotron. Atomics 6, No. 4, 23-5(1950) July-Aug.

Brief note is made of a modification of the G-E synchrotron at Schenectady which deflects the electron beam through a foil window in the doughnut. No glow from the beam of 70-Mev electrons was visible but a trace several inches long was recorded on photographic film.

5518 Energy Dependence of Proton-Proton Scattering, 18.8 to 31.8 Mev. Bruce Cork. UCRL-691, May 15, 1950. 22p. (See also NSA 4-3532.)

Measurements have been made of the absolute differential cross section of proton-proton scattering at 90° in the center

PHYSICS

of mass system. The energy of the incident protons was varied from 31.8 Mev down to 18.8 Mev, and an energy interval of ±1.0% was selected by means of a deflecting magnet. Apparatus using a proportional counter and a triple coincidence method was used to reduce the background. Measurements were made simultaneously, using the apparatus for measuring the angular distribution at 31.8 Mev and a single charge integrator for collecting the incident proton beam. The cross section at 90° C.M. varies approximately as the reciprocal of the energy of the incident protons over the range investigated. Data are presented to show this dependence. Comparison is made with a Yukawa potential well, and with the tensor model selected by Christian and Yoyes. 19 references. (auth)

5519 Cascade Showers in Lead. Kenneth M. Crowe and Evans Hayward. UCRL-719, May 26, 1950. 14p.

A study has been made of the energy and angular distributions of the electrons produced when the x-ray beam from the 322-Mev Berkeley synchrotron falls on a slab of lead one-half inch in thickness. A cloud chamber containing the piece of lead was in a magnetic field of 1800 gauss. Measurements were made on 1286 electron secondaries having energies greater than 3 Mev. The energy and angular distributions of these electrons are in satisfactory agreement with the theory. (auth)

5520 Asymptotic Expression for the Stopping Power of K-Electrons. L. M. Brown. Phys. Rev. 79, 297-303(1950) July 15.

An asymptotic form for the high energy stopping number of K-electrons (for any element) is determined by using the Born approximation expressions for the excitation and ionization probabilities of the K shell. The stopping number takes the form $B_k(\theta,\eta) = A(\theta)\ln\eta + B(\theta) + C(\theta)(1/\eta) + \ldots$, where η is a dimensionless quantity proportional to the energy of the incident particle and θ is proportional to the observed ionization energy of the K shell. Other results include the stopping number for hydrogen, obtained by sum-rule methods, to order $(1/\eta)$, and the results of M. C. Walske, obtained by numerical methods, for the low energy stopping number of K-electrons. (auth)

5521 An Attempt to Detect Thermal Energy Positrons. Leon Madansky and Franco Rasetti. Phys. Rev. 79, 397(1950) July 15 (Letter to the editor).

Positrons leaving a Cu^{64} source traveled through a vacuum parallel to a 100 gauss field, their arrival at a target being detected by means of the annihilation quanta. A 150-volt grid which would have stopped positrons with energies below 150 ev made no appreciable difference in the collection, indicating that thermal positrons were not leaving the copper. Possible reasons given are: (1) positrons do not diffuse through a crystal lattice, but are trapped in potential minima and are annihilated before moving appreciable distances; (2) positrons diffuse through the lattice but are trapped at the surface; and (3) positronium is formed, and even if it should diffuse out of the material, it would not be detected in these experiments.

5522 The Coherent Neutron Scattering Cross Sections of Nickel and Its Isotopes. W. C. Koehler, E. O. Wollan, and C. G. Shull. Phys. Rev. 79, 395(1950) July 15 (Letter to the editor).

PHYSICS

Neutron diffraction measurements were made, with a crystal spectrometer, on 3 samples of NiO enriched in Ni^{58}, Ni^{60}, and Ni^{62}, respectively. The scattering properties were found to be widely different, with Ni^{58} contributing nearly the entire amplitude of normal nickel while the very small contributions from the others were opposite in sign and nearly cancelled.

5523 On Charge Independence and High Energy Scattering. Robert Jastrow. Phys. Rev. 79, 389(1950) July 15 (Letter to the editor).

Considering the Berkeley results indicating a roughly isotropic cross section for p-p scattering at 345 Mev, compared with the strongly anisotropic high energy n-p scattering, it is shown that a charge-independent static potential is not necessarily excluded. An interaction is assumed consisting of a strong short-range repulsion surrounded by an attractive exponential well and is fitted to the low energy scattering.

5524 On Neutron-Proton Scattering. M. Watanabe, J. Miida and M. Sato. Progress Theoret. Phys. 5, 162-4(1950) Jan.-Feb. (Letter to the editor).

Using a differential analyzer to solve the Schroedinger equation for n-p scattering, the authors calculated the singlet and triplet phase shifts and cross sections at different neutron energies by varying certain parameters (width and depth of the Yukawa potential well, meson mass). Results are compared with the calculations of Blatt and Jackson (Phys. Rev. 76, 18(1949)). In addition, the differential cross section was computed for 90-Mev neutrons.

5525 The Range-Energy Relation in Nuclear Emulsions. Pierre Cuer, Jean-Jacques Jung, Denyse Magnac-Valette, and Serge Gorodetzky. Compt. rend. 230, 2280-2(1950) June 26 (in French).

Range-energy data in Ilford B_1, C_2, C_3, E_1, and D_1 emulsions of protons obtained by the bombardment with deuterons of a number of light isotopes are presented. The results are compared with a number of range-energy formulas.

5526 Stopping Power of Nuclear Emulsions for Ionizing Particles. Hervasio G. de Carvalho. Anais acad. brazil. cienc. 22, 73-6(1950) Mar. 31.

A similar article by the same author was published in Phys. Rev. 76, 1729-30(1949) Dec. 1., and was listed in Nuclear Science Abstracts as NSA Abstract 4-1304.

5527 The Theory of the Compton Effect Generalized to Particles of Spin $\hbar$. Gerard Petiau. Compt. rend. 230, 2262-4(1950) June 26 (in French).

The author calculates the diffusion cross section generalizing the Compton effect in which a Dirac particle of spin $\hbar/2$ absorbs a transverse vectorial particle of spin $\hbar$ and emits a particle of the same type, but not necessarily of the same mass. (auth)

5528 Beta-Gamma and Gamma-Gamma Angular Correlation Experiments on Sb^{124}. J. R. Beyster and M. L. Wiedenbeck. Phys. Rev. 79, 169-70(1950) July 1 (Letter to the editor).

β-γ coincidences involving only the 2.4-Mev β and 0.6-Mev γ from Sb^{124} were found with scintillation detectors and the observed symmetrical angular correlation function is illustrated. No definite angular momenta or interaction

PHYSICS

can be assigned at present. An essentially symmetrical correlation function was also found from coincidences between the 1.7-Mev γ and the 0.6-Mev γ.

5529 The Detection of Positron-Conjoint Nuclear Gamma-Radiation. Herbert E. Kubitschek. Phys. Rev. 79, 23-7(1950) July 1.

Absorption technique is described for the rapid detection and measurement of nuclear γ radiation from positron emitters. Positrons were magnetically removed and their annihilation radiation was screened from the γ-detecting region. Applicability of the method was shown in the verification of the energy and intensity of the γ ray from Cu^{64}. The method was further used to find a new γ ray of 0.81 ± 0.01 Mev from Ti^{45}; the number of positrons per γ is 19 ± 2. The positron maximum energy of 1.00 ± 0.02 Mev was also observed, and K-electron capture demonstrated. (auth)

5530 The Disintegration of As^{72}. J. Y. Mei, Allan C. G. Mitchell, and C. M. Huddleston. Phys. Rev. 79, 19-22(1950) July 1.

The spectra of the various radioactive arsenics produced by high energy α-particle bombardment of gallium have been studied using a magnetic lens spectrograph. These isotopes consist of As^{72} (26 h), As^{74} (19.5 d), As^{73} (90 d) and As^{71} (60 h). The main investigation concerns As^{72}. This element is found to emit five positron groups of end-point energies 3.339 (19.3%), 2.498 (64.6%), 1.844 (12.1%), 0.669 (5.0%) and 0.271 Mev (2.0%). A strong γ ray of energy 0.835 Mev together with many weak γ rays with energies up to 3 Mev have been found. The levels of the product nucleus Ge^{72} agree well with those found from a study of Ga^{72}. The highest energy positron group has a forbidden shape. The spectrum of As^{74} consists of one γ ray of energy 0.593 Mev, two negatron groups of energies 1.45 and 0.82 Mev together with a positron group of energy about 0.96 Mev. As^{73} disintegrates by K-electron capture and the emission of an internal conversion line corresponding to a γ ray of 0.052 Mev. An internal conversion line corresponding to a γ ray at 0.162 Mev is ascribed to As^{71}.

5531 Internal Conversion and Energies of γ Lines from Co^{60}. Kai Siegbahn and Martin Deutsch. Arkiv Fysik 2, No. 1, 9-15(1950).

The internal conversion lines of the two hard γ lines in Co^{60} have been investigated in a large double-focusing spectrometer. A new determination of the γ energies yields the values 1.174 and 1.1338 Mev. The stopping power in copper for the conversion electrons from the lines have been measured. The K internal conversion coefficients for the two lines are 2.12×10^{-4} and 1.68×10^{-4}. The best fit to theory is had by assuming that both γ rays are electric quadrupole lines.

5532 Internal Conversion of the Gamma-Rays from Rh^{106}. Franz Metzger. Phys. Rev. 79, 398(1950) July 15 (Letter to the editor).

Experimental values of 5.4 ± 1.5 and < 2.5 for the K conversion coefficients of the 0.51- and 0.73-Mev γ rays from Rh^{106} are compared with the theoretical values 4.90 and 1.95 for electric quadrupole and with 13.4 and 4.5 for electric octupole radiation. Quadrupole radiation is indicated, in contrast with the results of correlation experiments.

PHYSICS

5533 Measurement of the Gamma-Ray Energy of K^{40}. P. R. Bell and Judith M. Cassidy. Phys. Rev. 79, 173-4(1950) July 1 (Letter to the editor).

Pulse height distribution curves, obtained with a NaI, thallium activated crystal scintillation spectrometer are illustrated for Na^{24}, K^{42}, and naturally active K^{40}. Their forms are explained and the respective γ rays of 2.76, 1.51, and 1.46 Mev are identified.

5534 On the Beta-Gamma Angular Correlation. David L. Falkoff and G. E. Uhlenbeck. Phys. Rev. 79, 334-40(1950) July 15.

The angular distributions for the components of a line in a β transition are exhibited for use in obtaining numerical values for the angular correlation between successive nuclear β and γ radiations. The calculations are made with each of the five linearly independent electron-neutrino interactions (assuming $Z = 0$) for allowed and first and second forbidden β transitions. In general, the theory yields an angular correlation for forbidden β transitions which will vary with the interaction and the degree of forbiddenness, and thus affords a means of distinguishing between these. It is shown that no angular correlation is to be expected whenever, (a) the β transition is allowed, (b) the transition is classified as forbidden but has an allowed energy spectrum, (c) only the low-energy β particles are counted. (auth)

5535 On the Directional Correlation of Successive Nuclear Radiations. David L. Falkoff and G. E. Uhlenbeck. Phys. Rev. 79, 323-33(1950) July 15.

The theory of angular correlation is given in a form applicable to the successive emissions of any nuclear radiations. It is shown that the theoretical specification of angular correlation requires two kinds of information; namely, the angular momenta of the nuclear states and emitted radiations, and the Hamiltonian interaction between the outgoing particles and nucleus. The former information enters in the same way in all angular correlations while the latter, differing with the kind of particles emitted, is needed to obtain the angular distributions associated with each component of a line. The structure of such angular distributions is studied in relation to isotropy requirements and an explicit construction to exhibit them is given. Systematic simplifications in the calculation of angular correlation functions $W(\theta)$ are shown to result from several theorems relating to the combinations of transformation coefficients occurring in $W(\theta)$. These make possible a complete tabulation of $W(\theta)$ in canonical forms applicable, on proper specialization, to any angular correlation in which the angular momentum of the decay products in either transition is 1 or $2\hbar$. The specializations for α and γ emission are given. (auth)

5536 Proton Capture Radiation of Fluorine-19. E. R. Rae, J. G. Rutherglen, and R. D. Smith. Proc. Phys. Soc. (London) 63A, 775-7(1950) July 1 (Letter to the editor).

When F^{19} captures a proton of low energy, the compound nucleus Ne^{20} has an excess energy of 13 to 14 Mev. By means of a pair spectrometer and a thin target of calcium fluoride evaporated onto a brass plate, a small γ activity of 12.0 Mev was found. The suggestion is that the decay is to the 1.4 Mev level others have found in Ne^{20}. The main decay is to O^{16} by α emission with a subsequent γ ray of 6.1 Mev.

PHYSICS

5537 Radioactive ^{165}Er. F. D. S. Butement. Proc. Phys. Soc. (London) 63A, 775(1950) July 1 (Letter to the editor).

Holmium oxide of over 99.97% purity was bombarded with 10 Mev protons. The resulting activity in the erbium fraction consisted solely of electromagnetic radiation with a half-life of 10.0 ± 0.1 hr. This was measured as holmium x-rays and the activity was, therefore, attributed to K-capture in Er^{165}, formed in the reaction $Ho^{165}(p,n)Er^{165}$. This contradicts a former assignment, by others, of a sole positron activity of 1.1 min half-life.

5538 The Radioactivity of Hf^{181}. Martin Deutsch and Arne Hedgran. Phys. Rev. 79, 400-1(1950) July 15 (Letter to the editor).

The assignment of a 345-kev γ ray to Hf^{181} in the decay scheme of Wiedenbeck and Chu (Phys. Rev. 75, 226(1949)) is questioned on the basis of conversion electron coincidences. The abundance of the 345-kev radiation, relative to that of known 45-day activities, was much greater in the older of two samples of neutron-irradiated hafnium, indicating a longer period than that of 45-day Hf^{181}.

5539 Some Characteristics of the 11-Day Neodymium(147). C. E. Mandeville and E. Shapiro. Phys. Rev. 79, 391(1950) July 15 (Letter to the editor).

Exceptionally pure Nd_2O_3 was irradiated with slow neutrons. Beta-ray end points were observed at 0.17 and 0.78 Mev and two x-ray energies were measured as 35 kev and 0.58 Mev. Critical absorption measurements indicated that the 35 kev radiation was promethium x-rays and that internal conversion accompanies de-excitation of Pm^{147*}.

5540 The Bohr Formula for the Rydberg Constant. Raymond T. Birge. Phys. Rev. 79, 193-4(1950) July 1 (Letter to the editor).

The Rydberg constant is recalculated by transforming Bohr's original equation $R_\infty = 2\pi^2e^4m/h^3c$ into a form best fitted to take advantage of recent high precision results in new fields of work. Taking into account the various probable errors, the result is $R_\infty = 109{,}733.61 \pm 7.03\ cm^{-1}$, nearly all the uncertainty of which is attributed to magnetic field measurements in finding the gyromagnetic ratio of the proton.

5541 Effect of Assumed Range of Tensor Force on the Neutron-Proton Interaction. A. A. Broyles and M. H. Hull. Phys. Rev. 79, 247-57(1950) July 15.

Agreement of theory with experimental deuteron properties is believed possible, without extreme modification of central interaction potential, by increasing the range of tensor interaction. The calculations are simplified by confining the tensor potential to an infinitely thin shell. The quadrupole moment and zero-energy cross section can be realized by a suitable choice of radius of the shell. Experimental results for the total cross section are reproduced up to an incident particle energy of 15 Mev and the angular anisotropy is not in disagreement with experiment for attractive interaction. The theoretical cross section is smaller than experimental values for higher energies except for repulsive tensor force, and the anisotropy is only in qualitative agreement with the recent work at Berkeley.

PHYSICS

5542 Neutron-Proton Capture and Coherent Scattering Amplitudes. Lamek Hulthén. Phys. Rev. 79, 166 (1950) July 1 (Letter to the editor).

Theoretical neutron-proton capture cross sections have been obtained for meson masses 200 m and 300 m. These are 0.303 and 0.311 barn, respectively, at a neutron velocity of 2200 m/sec. The quoted experimental value is 0.313 barn. The coherent scattering amplitudes were calculated as -3.40 and -3.85×10^{-13} cm, respectively, while a quoted experimental value is -3.75×10^{-13}. Present best values for the deuteron binding energy and the epithermal neutron-proton scattering cross section were used and a central Yukawa potential was assumed in both ^3S and in ^1S states, with the same range in both.

5543 On the Concept of the Nuclear Potential. K. Baba, D. Itô, T. Miyazima, and M. Sasaki. Progress Theoret. Phys. 5, 159-60(1950) Jan.-Feb. (Letter to the editor).

The authors state that in solving the deuteron wave function only the second order Moller interaction need be used. Using a Feynman diagram, they show how 4th order processes can be represented by combinations of 2nd order processes. The details of the calculation will be published in a future article.

5544 On the Electromagnetic Properties of Nucleons. M. Taketani, S. Machida, and T. Tamura. Progress Theoret. Phys. 5, 150-2(1950) Jan.-Feb. (Letter to the editor).

The authors have calculated, using Tomonaga-Schwinger's method of canonical transformation, how the electromagnetic properties of a nucleon is altered by the scalar or pseudoscalar meson field surrounding the nucleon, up to the orders of ef.[2] They omitted DSS-terms in the integrand, in which the arguments do not circulate (D and S are the 4-dimensional delta-functions of meson and nucleon, respectively, and DSS means the product of one meson delta-function and two nucleon delta functions), interpreting them as mass renormalization terms. The terms which can be interpreted as vacuum polarization effects of the nucleon field vanish exactly. Hence, there remain only Lamb shift type corrections and the divergencies which arise from these terms can be subtracted as charge renormalization effects for nucleons. Then, the results become finite and can be compared with experiments. Considering various kinds of external electromagnetic fields, they have calculated the anomalous magnetic moment of a nucleon, the interaction energy between a neutron and an electron, and the contribution to the level shift of a hydrogen atom. Results obtained agree closely with Case's results (Phys. Rev. 76, 1(1949).

5545 On a Fourth-Order Meson-Equation. W. Thirring. Phil. Mag. 41, 653-62(1950) July.

By applying the usual formalism of quantized fields to higher order equations, the field is interpreted as belonging to particles which possess states of several rest masses. In order to avoid the problem of different rest masses the author uses the field equation, $(\Box^2-\mu^2)(\Box^2-\mu^2)\,\varphi\,(x) = 0$. By taking a reasonable meson mass and a simple scalar coupling, the coupling constant can be adjusted to well known nuclear data, and the self energy of the nucleon due to the meson field can be calculated. The author shows that by taking

higher order equations some renormalization terms, which used to be infinite, are now finite and have an actual small numerical value. 10 references.

5546 On High Energy Nucleon-Nucleon Scattering. K. M. Case and A. Pais. Phys. Rev. 79, 185(1950) July 1 (Letter to the editor).

Recent high-energy scattering experiments seem to indicate a sizable difference between the n-p and p-p interactions, in contrast to the charge independence at low energies. The authors point out that it seems possible, however, to give a charge independent description of nuclear force in that the p-p experiments can be accounted for on the basis of a spin-orbit interaction, of the type familiar from atomic phenomena, without drastically modifying previous n-p scattering interpretations.

5547 On the Magnetic Shielding in He and H_2. Egil Hylleraas and S. Skavlem. Phys. Rev. 79, 117-22 (1950) July 1.

The magnetic shielding constant for the He atom (i.e., the value of $(-\Delta H/H)$ at the nucleus), has been calculated to a high degree of accuracy by comparison of values obtained from a number of known first and higher approximations to the wave function. Its value is 5.9938×10^{-5}. Next, the shielding constant for the H_2 molecule with respect to either of the nuclei has been found in the first approximation to be 2.6614×10^{-5}. The corresponding value derived from the Lamb formula is 3.1648×10^{-5}. The difference is due to the combined effect of both the center of mass and the center of the electronic charge lying outside either of the two nuclei. The numerical value 0.5034×10^{-5} of the difference fits well with the value 0.53×10^{-5} reported by Ramsay (Phys. Rev. 78, 699(1950)) as derived from measurements of the spin-rotational interaction constant of the H_2 molecule. However, there is also a second-order perturbation effect due to the perturbation of the ground state of the molecule by the magnetic field. By a special method its upper limit has been estimated to be 0.2864×10^{-5} and with a sign such as to weaken the magnetic field. Hence, the upper limit of the total shielding constant of H_2 should be 2.9478×10^{-5}. (auth)

5548 On the Stochastic Theory of Continuous Parametric Systems and Its Application to Electron Cascades. H. J. Bhabha. Proc. Roy. Soc. (London) 202A, 301-22(1950) Aug. 7.

A mathematical definition of an assembly of continuous parametric systems is given and its theory developed, making it correspond precisely to most of the continuous parametric assemblies known in nature. Certain general theorems are deduced which hold for all such assemblies. It is shown that the usual method of treating a continuous parametric assembly by dividing up the domain of the parameter into a number of small segments, treating each segment as belonging to a discrete state of the system, and then passing to the limit of making the segments infinitely small does not lead to a continuous parametric assembly of the type described above, but one of much wider generality which does not correspond to any type of physical system met with in nature. The general method and the theorems are of immediate application in calculating the fluctuations of the

number of particles in chain reacting systems, and not only for systems in thermodynamic equilibrium. The general theory is applied, as an illustration, to the stochastic treatment of an electron cascade to derive the differential equations which determine the functions from which the mean number of particles in any energy interval, and the mean square deviation of this number, can be calculated. It is shown how the application of the usual method to this problem leads to the same results only if particular boundary conditions are imposed on the problem. (auth)

5549 Quantum Theory of Rest-Masses. M. Born, H. S. Green. With Appendices by K. C. Cheng and A. E. Rodriguez. Proc. Roy. Soc. Edinburgh 62A, 470-88 (1949).

The object of this paper is to show that the principle of reciprocity is a powerful tool for restricting the choice of Lagrangians and producing those which correspond to observed particles. This being accepted, the whole of quantum mechanics separates into two distinct fields: the first, the determination of the different possible Lagrangians and the corresponding rest-masses for free particles and the coupling between them; the second, the derivation of the wave functions from the Lagrangians for a given experimental arrangement. It is shown how the Lagrangians are to be derived from the Principle of Reciprocity, and this is, in turn, followed by the general field theory and second quantisation procedure which are independent of the actual Lagrangians used. The method is then applied in detail to the determination of the masses of particles with spin zero or one, and it is shown that among the most stable particles occur some which have masses in close agreement with experimental determinations of the meson masses. There exist also particles of spin one and zero rest-mass which may be interpreted as photons. Finally, in the first appendix, particles with spin one-half are considered, and it is found that they include mesons, as well as particles with vanishing rest-mass which may be interpreted as electrons or neutrinos, according as they are charged or not. (auth)

5550 The Range and the Mean Free Path of High Energy Nucleons in Nuclear Matter. Y. Fujimoto and Y. Yamaguchi. Progress Theoret. Phys. 5, 141-2 (1950) Jan.-Feb. (Letter to the editor).

Using the method of Heisenberg and Bagge (Leipzig. Beriger Berichte 89, 369(1937) and Ann. Phys. 35, 431(1939)), the range, collision mean free path, and cross section for energy loss of a high energy nucleon in nuclear matter has been calculated. A central Yukawa potential with a depth of 30 Mev and the Fermi-gas model for the nucleus was adopted. On the basis of the results, shown graphically in the article, the authors have been able to interpret the high energy nuclear experiments at Berkeley and the stars caused by π^- meson capture.

5551 The Second Approximation of the Asymptotic Phase for the Yukawa Potential, Treated with Laplace-Transformations. Gunnar Källén. Arkiv Fysik 2, No. 1, 33-46(1950).

The Schrödinger equation is here solved with the aid of an expansion in the coupling constant. Every term in the series is written as a Laplace-integral, and from this the

PHYSICS

asymptotical behavior of the solution is easily obtained. The asymptotic phase will then also be expressed as a power series in the coupling-constant. The first term corresponds to the usual Born's approximation, the higher terms can be considered as corrections for this formula. In this paper the explicit calculations are carried out only to the second approximation and for small angular momenta (S- P- and D-states). (auth)

5552 Some New Functions of Interest in X-ray Crystallography. M. J. Buerger. Proc. Natl. Acad. Sci. U.S. 36, 376-82(1950) July.

A previous discussion (Buerger, Acta Cryst 3, 87-97(1950)) of the relations between fundamental sets and vector sets is extended to sets of weighted points and to density maps. An image-seeking function is derived which maps out the atom locations in a crystal structure. The discussion is carried out largely in terms of three-dimensional Patterson functions.

PHYSICS

5553 Theory of Longitudinal Photons in Quantum Electrodynamics. Suraj N. Gupta. Proc. Phys. Soc. (London) 63A, 681-91(1950) July 1.

The radiation field is quantized by introducing four types of photons—two transverse, one longitudinal, and one scalar. The scalar photons are treated by using an indefinite metric, and it is found necessary to modify the usual supplementary condition slightly. The present theory offers a justification for the symmetrical treatment of the four components of the electromagnetic potential, recently applied by a number of authors, and proves to be very convenient in applications. The results of physical interest, however, are the same as obtained from the ordinary formulation.

5554 Radiochemical Methods in Physical Chemistry. L. Tordai. Atomics (London) 1, 196-200(1950) July.

A similar article by the same author was published in Mfg. Chemist 21, 11-14(1950) Jan. and was listed in Nuclear Science Abstracts as Abstract 4-3733.